Study project Shouraizou

A survey on technical innovation in Japan compared to the Netherlands

Final report

University of Twente
Department of Electrical Engineering
Study association Scintilla

Colofon

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More than 15 years have passed. . .

Leaving from the soot and noise of Tokyo, I joined the University of Twente as a research fellow in the group of Professor Cock Lodder. It was 1988. There was no Dutch language course for foreigners in the university when I arrived. I learned little Dutch, wonder that I really learned the Netherlands through getting many Dutch friends, knowledge, cultures, etcetera. . .

More than 15 years have passed since then. Now a Japanese young football player, Shinji Ono, is playing in your country with your language. And you, Shouraizou students, visited Japan with conscientious preparation for study including 'een beetje' (sukoshi) Japanese language. I was very proud to introduce such excellent students from my studied university and believe that you have reached the fruitful goals that you aimed at.

What you saw, experienced and learned in Japan through Shouraizou's study will make the most of your ability to contribute to the friendship between two countries but also to create the better world of tomorrow, I expect.

Takeo Masuda
Senior staff - director of standardization division
Optoelectronic Industry & Technology Development Association (OITDA)
Tokyo, Japan

Kakusin no genba ni okeru kyouiku

Education is more than studying lecture notes. The educational program of the University of Twente has a history of encouraging students to broaden their view, also beside the official curriculum. The various study associations of our university are playing an important role in this process. The Shouraizou study project has been organised by students from "Scintilla", the study association of the department of Electrical Engineering. The main goal of this project is to bring students in contact with industrial and academic research and development, to study and discuss the various aspects of innovation.

I was very honoured to be one of the advisors and with great pleasure and interest I accompanied the students during the tour. I visited Japan many times but the Shouraizou study tour belongs to the very special ones and will be remembered for a long time. The most positive experience for me was to experience the motivation, knowledge and enthusiasm of the students. The way they participated in the discussions and the large number of questions they asked made me proud to belong to this group.

The success of the tour is also connected with the excellent organization and preparations of all Japanese hosts. Without their cooperation such a high quality study project could not be organized. The intensive involvement of the Japanese industries and universities has made this visit as an unforgettable experience for all of us. Although with this report Shouraizou reaches its final destination, I certainly believe that Shouraizou is a lifetime experience.

An unforgettable afternoon took place at the Tohoku University where about 60 Japanese and Dutch students where mixed in teams trying to build the longest bridge with only thin thread and packages of spaghetti. From a technical point of view this activity was a great success, but the most important aspect was the positive contacts between young people from two different countries. This was also confirmed during dinner and drinks after this session.

Because this study project is based on the principle 'for students by students' a special group formed the organizing committee of Shouraizou. The great success of this study project is also due to their enthusiasm and organizational skills. Special thanks to the seven organizers.

Finally, I am very grateful that I was one of the participants of Shouraizou.

Cock Lodder
Professor Systems & Materials for Information storage

"Curiosity is the key to creativity"

—Akio Morita, founder of Sony

Curiosity is the driving force of human culture and curiosity is what has driven us to the other side of the globe. It is the reason we visited so many people and the reason we asked them so many questions. We have been searching for an answer to a question, the question that links creativity to entrepreneurship: the question of innovation.

As students we are going through the final stage of our preparation for the 'real' world. Our education at the University of Twente has filled us with fascination about the marvels of technology. The more we learn about the creativity of past designs and ideas, the more curious we become. The fruit of this labor is visible in everyday life and there is no home in the Netherlands where no innovative device can be found that makes our lives more comfortable.

When searching for state-of-the-art engineering the only way to look is east. Japan, an archipelago surrounded by an aura of mystique, has become synonymous with Electrical Engineering of the future. But what we have seen is not a dream of the future, but the reality of tomorrow. In Japan the shouraizou, the vision of the future, is reality.

Japan has proven that with effort and creativity as a cause, and technology and communication as a tool, it is possible to continuously change the world for the better. Many of the leading global high-tech companies are Japanese, as are the best universities. We are honored that these prestigious institutes have had us as guests and helped us to satisfy our curiosity.

Visiting Japan provided us with a new perspective. We have had the chance to think and look outside the box, providing food for thought and reflection to evaluate our own culture. To appreciate another culture, we must enter it with an open mind. Although everyone is ethnocentric by nature, coming to understand the Japanese people caused a paradigm shift among us. I am convinced that undertaking study tours contributes to the tolerance and respect between people, by realizing that there are more ways to view life than one. The tour truly provided us with the deepest respect for the Japanese people.

We, as student participants, owe this invaluable experience to the efforts of seven talented organizers. We wish to thank them for making this unforgettable experience possible.

Jasper Klewer
Student participant

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Chapter 1

General introduction

Chapter contents

1.1 Introduction

In this chapter, the study project will be introduced. In section 1.2 you will find more information on the goals, theme, name and the various parts of the project. Section 1.3 will introduce the organizing committee, the associations Scintilla and IEEE SB Twente, and the University of Twente. Next the project participants, as well as the supervisors and lecturers will be introduced in section 1.4. The chapter is concluded with an overview of the contents of this report.

1.2 Study project

This section contains general information on the study project. In the first subsection, the various goals of the project will be indicated. After that, the theme and the country that are the subject of our investigation will be presented. Subsection 1.2.4 explains the Shouraizou name and logo. Finally, a general outline of the entire project and a brief description of its various parts will be given.

1.2.1 Goals

When the Shouraizou committee started with the organization of the study project, they had several goals in mind. Some of the goals that the committee would like the participants to achieve are:

- Get to know a non-European country from 2 different views:
    1. study of culture, climate, politics, geography, language, economy, social aspects, etcetera;
    2. study of activities in Electrical Engineering - the level of education, research and the ways they are implemented;
- Learn some of the aspects from the work of an electro technical engineer, within a company in a non-European country;
- Get to know people in companies, research institutes and universities, both in the Netherlands and abroad;
- Gain some knowledge in a working area of Electrical Engineering.

1.2.2 Theme

The Shouraizou study project aims to investigate technical innovations in Japan, in industry, universities and research centers and compare this with the situation in the Netherlands. There has been a lot of talk about 'innovation' (knowledge-based changes in products and processes, in industry, technology and science) in Dutch society and politics recently: there is much worry about a lack of innovation and knowledge in our country, which resulted for example in the foundation of the Innovation-platform, with Prime Minister Jan-Peter Balkenende, several ministers, representatives of major Dutch companies and the Rector Magnificus from the University of Twente. But why did we choose for technical innovation as the theme of our study project?

It is our vision that people have spent enough time on discussion of and research into innovation: it is time to have things done. Aim of the project is to show a group of future engineers what, where, why and how people are innovating, so that they learn what innovation is. Not by just researching it, but by seeing it with their own eyes. In this way they learn not only that innovation is important, but also how they should use it in their future careers. Moreover, we believe that innovation is closely related to both activities in Electrical Engineering, education and research, and culture, economy and social aspects. Participants have studied all these factors for Japan and got to know this country from the different views described in the previous subsection.

1.2.3 Country

Having said that the project is organized at the Department of Electrical Engineering and that its theme is technical innovation, very few words have to be spent on the decision to let the project focus on Japan. Being one of the most innovative countries in the world for the last decades, Japan is globally well-known as a high-tech country, with a lot of interesting products and services to be seen in companies, institutes, universities and (more than anywhere in the world) everyday life. However, an even better reason may be the enormous attracting power of its mystic language, intriguing culture, astonishing nature and friendly people.

1.2.4 Name and logo

The project is called 'Shouraizou', which is the Japanese word for 'vision of the future'. This name covers the goal of the project as explained in subsection 1.2.1, which is to show participants what innovation is and what they can do with it themselves. During the project we wanted them to see, experience and create a vision of the future.

It did not take us much time to come up with a logo. The eye, a universal symbol for vision, combined with the Japanese flag, in our opinion explains very briefly and clearly what the project is about.

1.2.5 Project outline

The study project Shouraizou consists of several activities, that can be divided into 3 groups.

Main part is the research project, a survey on technical innovation in Japan, compared to the Netherlands. This research is carried out by the participants under supervision of academic staff members, using lectures, presentations and assignments. Since one cannot find everything in books, the study tour to Japan plays an important role.

Secondly, the study project consists of several cultural activities. As a preparation before the tour, participants have watched Japanese movies, had Japanese dinner and attended a symposium. Most participants also followed an extensive language course. Most cultural activities of course took place during the study tour in November 2004: we experienced everyday-life in Japan and visited a lot of places that are well worth seeing.

The last part of the project is less focused on Japan: participants have performed so-called contract research assignments for companies and universities in the Netherlands. These assignments are primarily essential for the funding of the study project.

1.3 Organization

Shouraizou is a project organized by a committee at the University of Twente, founded by Electrical Engineering study association Scintilla and endorsed by IEEE Student Branch Twente. More information on these organizations can be found in the following subsections.

1.3.1 Shouraizou committee

The Shouraizou committee was founded in the summer of 2003, when some active members of study association Scintilla decided that, after the huge success of predecessor ShinTabi in 2000, it was time for a new study project to start. It consists of 7 enthusiastic, ambitious and very expierenced Electrical Engineering students, that voluntarily spend one and a half year of their study time on the organization of the study project.

The members of the committee are (in alphabetical order):
Bayan Babakhani - Treasurer
Siebe Berveling - Research Manager
Arjen Damstra - Public Relations Officer
Johan Engelen - Travel Coordinator
Roland Meijerink - Chairman
Erik Staijen - Administrator
Martin Wassink - Contract Research Manager

A picture of the entire committee can be found in figure 1.1, pictures of the individual committee members are presented in subsection 1.4.1.

1.3.2 Study association Scintilla

E.T.S.V. Scintilla is the study association for the Department of Electrical Engineering at the University of Twente. It was founded on 9th September 1965 and

Figure 1.1: The Shouraizou committee (from left to right: Bayan, Martin, Johan, Arjen, Siebe, Erik and Roland)

currently has over 700 members, of which more than 400 are students in Electrical Engineering. This makes Scintilla one of the oldest and biggest associations at the University of Twente. Its name is derived from the flashes that can be seen, when small particles collide with a fluorescent plate.

As stated in the articles of association, Scintilla has the following goals:

- Expand the practical and theoretical knowledge of its members in the field of Electrical Engineering;
- Look after the interests of students Electrical Engineering at the University of Twente;
- Support the course of business in the education of Electrical Engineering;
- Improve the mutual contacts between its members.

Nowadays, the association is run by more than 100 active members that participate in committees and working groups, including a board of 6 students that are doing this full-time for one year.

Scintilla's activities can be divided into 4 main areas: study-related activities, publications, facilities and others.

Study related activities

Every month, Scintilla organizes an excursion to or a lecture given by a company that is of interest for its students. These excursions and lectures offer students the opportunity to get in contact with companies that could be their future employer. Besides these monthly activities, an annual symposium is organized. On this day, interesting speakers from the Netherlands and abroad focus on a specific area in the field of Electrical Engineering.

Publications

About 8 times a year Scintilla sends out a semi-scientific magazine to keep members informed of research at the Department of Electrical Engineering, developments in education, activities of the association and much more. Moreover, every year a yearbook is published, to give an overview of the developments and activities of the past year.

Facilities

Scintilla has its own room at the university campus that not only provides workspace with computers and a conference room, but also is the most important meeting place for students during breaks, to have a cup of coffee. Scintilla also runs a small pub, where students and academic staff members can have a drink at the end of the week and discuss their experiences with each other. Finally, Scintilla has its own store, which sells electrical components, study books, computers and office supplies.

Others

There are numerous committees that do not fit in one of the previous areas. This includes committees that organize recreational activities, maintain the computer network, organize special introduction days for the freshmen at the start of the year and much more.

1.3.3 IEEE Student Branch Twente

The Institute of Electrical and Electronics Engineers (IEEE) is the world's largest technical professional society. Founded in 1884 by a handful of practitioners of the new electrical engineering discipline, today's Institute includes 77,000 students within a total membership of nearly 377,000 members, who conduct and participate in its activities in 150 countries. IEEE-members are technical and scientific professionals making the revolutionary engineering advances, which are reshaping our world today.

The technical objectives of the IEEE focus on advancing the theory and practice of electronics, electrical engineering, computer engineering and computer science. To realize these objectives the IEEE has a worldwide representation through more than 1200 Student Branches and chapters.

IEEE sponsors scholarships, awareness programs, technical conferences, seminars and local meetings. Furthermore the IEEE publishes over 30% of the world's scientific literature in its field of interest and provides educational programs to keep its members' knowledge and expertise state-of-the-art.

World-wide, the IEEE operates in 10 geographical regions, subdivided by Sections in which local chapters and student branches organize activities. The Student Branch Twente is located in region 8, which roughly consists of Europe, Africa and the Middle-East. Next to annual conferences, technical meetings and other professional events, there are several student activities like the Region 8 Student Paper Contest, a two-year Student Branch Congress, awards-, scholarship- and exchange programs.

The IEEE Student Branch Twente was officially founded in 1989, but there are reports of branch activities that date back to 1968, only 7 years after the University of Twente was founded. Current activities of the Student Branch Twente include:

- Promotion and support of IEEE Membership at University of Twente;
- Organization and support of international events and study projects, mostly in co-operation with fellow student organizations;
- Helping students to find an internship, exchange program or other practical assignment abroad using the IEEE world-wide network;
- Participation in Region 8 activities (e.g. R8 Student Paper Contest, Student Branch Congress).

1.3.4 University of Twente

The University of Twente (UT) in The Netherlands is a young and entrepreneurial research university. Founded in 1961 and situated in the eastern part of The Netherlands, the university offers education and research in a wide range of engineering, behavioural, medical and social sciences. The education programmes of the university - 20 Bachelor programmes and an even larger number of Master's programmes - are acknowledged as the top of higher education in the Netherlands. The Electrical Engineering programme, for example, scored the highest rankings in recent polls among students and scientists. UT's unique campus offers a vast number of facilities to 7000 students and 2500 staff members, including modern research labs, fast internet connections, up to extensive sports facilities and student/staff houses.

In research, University of Twente has chosen a limited number of technology spearheads, in which the university wants to excel. UT's largest research institute is the MESA+ institute for nanotechnology, responsible for the largest Dutch nanotechnology programme. Other spearheads are information technology, biomedical technology, mechanics, processes and control. UT's research institutes aim at over 50 percent non-government funding and therefore closely cooperate with industrial partners.

'Entrepreneurial' is the keyword for the attitude the university is facing towards both education and research. The university was founded to become a key player in turning a post-industrial region into a truly knowledge-intensive one. UT is therefore always open for close relations towards society. The university actively stimulates entrepreneurship among students and staff, for example by offering them facilities for starting their own company. In research, UT is a partner for large companies, SMEs and government organizations. It participates in European and worldwide research projects.

In education, this entrepreneurial attitude means that UT is always in the forefront of introducing the newest educational concepts. In this way, a UT-student gets the best possible luggage for a career in industrial, scientific and other organizations.

1.4 People

Several people from the University of Twente have been active in the study project. In total there were 35 Master students involved, of which 7 are responsible for the organization of the entire project. Moreover, there were several academic staff members that took part in the project. These people will be introduced in the following subsections.

1.4.1 Committee

The members of the Shouraizou committee are presented in table 1.1.

1.4.2 Participants

The 35 participants of study project Shouraizou are all (former) Master students in Electrical Engineering at the University of Twente. Some of them have only recently started their Master, whereas others have finished their thesis during the project. The students are introduced in tables 1.2 and 1.3.

1.4.3 Supervisors

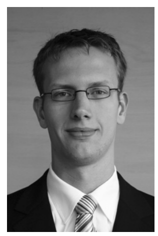
There are several academic staff members that played an important role in the study project. Some of them supervised the project and give lectures, whereas others have traveled with us during the study tour. These people are presented in tables 1.4 and 1.5.

Bayan Babakhani
Treasurer

Siebe Berveling
Research Manager

Arjen Damstra
Public Relations Officer

Johan Engelen
Travel Coordinator



Roland Meijerink
Chairman

Erik Staijen
Administrator

Martin Wassink
Contract Research Manager

Table 1.1: Shouraizou committee members


Frank van der Aa


Jos Ansink


Casper van Benthem


Bert van den Berg


Maarten Bezemer


Niek Bouman


Lodewijk Bouwman


Pieter Cuperus


Eelco Dalhuisen


Bertjan Davelaar


Michel van Dijk


Michel Franken


Thomas Janson


Joost de Klepper


Jasper Klewer

Table 1.2: Shouraizou participants


Matthijs Krens


Sebastiaan van Loon


Mathijs Marsman


Paul Omta


Laurens van Oostveen


Harald Profijt


Dirk van Schaijk


Martin Schepers


Casper Smit


Bart Spikker


Janarthanan Sundaram


Rogier Veenhuis


Kasper van Zon

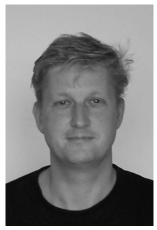
Table 1.3: Shouraizou participants.

Dr. Ir. S.J. de Boer
International Management

Prof. Dr. Ir. J.J. Krabbendam
Technology & Organisation

Prof. Dr. J.A. Stam
Technology & Organisation

Table 1.4: Study project supervisors and lecturers



Dr. Ir. L. Abelmann
Systems and Materials for Information storage

Prof. Dr. M.C. Elwenspoek
Transducers Science and Technology

Prof. Dr. J.C. Lodder
Systems and Materials for Information storage

Prof. Dr. Ir. A.J. Mouthaan
Educational director Electrical Engineering

Prof. Dr. Ir. B. Nauta
Integrated Circuit Design

Prof. Dr. Ir. C.H. Slump
Signals and Systems

Table 1.5: Study tour supervisors

1.5 Report outline

The outline of the project as presented in subsection 1.2.5 is the guideline for this report.

The most important part of the project consists of the research activities and these are presented in the first part of the report. Chapter 2 gives an abstract of the entire research project and the project set-up is discussed in chapter 3. The results of the preliminary research are given in chapter 4 and those of the micro research in chapter 5. Part I is ended with the final conclusion, recommendations and a bibliography.

The second part contains the other activities: information about the study tour, daily reports and pictures can be found in chapter 7. Results from the contract research assignments are presented in 8 and finally, in chapter 9 cultural activities are described.

PART I

RESEARCH ACTIVITIES

Chapter 2

Abstract research project

by Niek Bouman

The research project – the main part of the study project Shouraizou – comprises a survey on technical innovation in Japan, compared to the Netherlands. The project started with the formulation of the main research question, which reads as: *“What are the key factors that influence technical innovation in Japan and the Netherlands?”* To be able to answer this question, the research project has been split up into four parts. Each part has its own research sub-question(s).

Set-up

The first part consists of a literature study on technology and innovation, to gain more insight in topics such as “technical innovation” and “innovation” in general. The three other parts comprise the comparison between Japan and the Netherlands on three different hierarchical levels: *macro* (national and international level), *meso* (industrial sectors’ level) and *micro* (organizations’ level). The innovation study and the macro and meso research parts have been conducted prior to the study tour in November 2004, and the findings have been published in Shouraizou’s preliminary report. On the other hand, the micro research has been partially conducted prior to, as well as during and after the tour. The findings of the micro research can be found in this final report.

The central question of the innovation study reads: *“What definition of technical innovation and its characteristics are appropriate for our research?”* In this study, the book “Managing technology and innovation for competitive advantage” by Narayanan was used as a guideline. The outcome of the investigation was, besides a useful knowledge enrichment for every participant, a good input for the preparations of the excursions belonging to the micro research part, which is briefly described below.

The macro research part is characterized by the following question: *"What are important forces in society that support or inhibit innovation on the national and international level?"* The macro part comprises a PEST-analysis (Political, Economic, Social and Technological factors) extended with historical and geographical aspects.

The meso research part covers five divisions of the United Nations' ISIC Rev 3.1 industrial classification. For each division, the research question is: *"Which fields of Electrical Engineering are of interest and what are hot innovation topics in this division?"* Furthermore, the divisions have been analyzed with the help of the Diamond model of Michael Porter, in order to compare their (international) competitiveness.

The micro research question is put as follows: *"Which factors support or inhibit technical innovation on the organizations' level?"* Within the framework of this micro research, visits have been paid to Japanese as well as Dutch companies, universities and institutions. Prior to these visits, the students have gathered as much information about these organizations as possible. Additionally, general research questions have been formulated with the help of the knowledge gained during the innovation study.

Results

The last part of the research project is actually the integration of the research outcomes in order to find an answer to the main research question. Some conclusions are itemized here:

- The unique cultural characteristics of the Japanese people have a great influence on innovation in Japan. The unity of the Japanese people strongly supports their competitiveness. Their curiosity to new technology creates a beneficial domestic market for (Japanese) companies that want to sell their new innovations.
- Japan is more western-like than expected. Also the gap between Japanese and Western management structures becomes smaller.
- The bottom-up approach of innovation (e.g. an employee that takes the initiative and presents a new idea to the management), which is not uncommon in the Netherlands, encounters problems while being introduced in Japanese organizations. Japanese people find it difficult to express themselves freely to somebody with a higher status, because of the risk of insulting that person.
- Economically, both countries are currently facing a stagnating economy.
- The Japanese local (prefectural) governments together with the national MEXT ministry have a relatively large influence on innovation. A recent

change in the Japanese education funding system has resulted in a stronger competition between universities, and therefore impedes cooperation.

- Universities as well as big companies in both countries create spin-offs.
- According to the *“innovation paradox”*, the Dutch are not very successful in valorizing knowledge. Mainly because of this observation, there has been a strong focus on innovation recently in the Netherlands.

Chapter 3

Research introduction

This introduction first points out why the research project was set up. Then, the project's aim and the research questions are formulated. The way we performed the research project is set out next, and finally, it is explained how the subsequent chapters in this report are linked to each other.

3.1 Project window

'Innovation' has become a hot topic over the past years. Its importance is more and more recognized by governments. The European Union wants to establish a European Research Area [1, 2] and to have the European R&D expenditures equal to 3% of the gross domestic product [3]. In extent to this, the Dutch government has established the Innovation platform [4], which is one of their measurements in order to achieve their goal to become one of the leading researching countries [5]. In the Innovation platform, government, university and company representatives discuss the innovation process and suggest desirable adjustments to the Dutch policy. The Netherlands, and Europe in general, seem lagging behind in research and development compared to Japan. A lot of high tech products are of Japanese fabric instead of Dutch (or European). This research project contains the search for differences between these countries that are responsible for this.

3.2 Aim of the project

The purpose of the study project 'Shouraizou' is to obtain a better understanding of innovation, by looking at technical innovation in Japanese society and industry and comparing this to the situation in Dutch society and industry. The project's aim can be formulated as: to identify the most important factors that affect the level of technical innovation in Japan and in the Netherlands.

3.3 Research questions

The project's aim is translated into a main research question. This main research question is:

> (i) *What are the key factors that influence technical innovation in Japan and the Netherlands?*

Technical innovation, the term used in this research question, is a wide concept. Therefore it is necessary to make clear what definition of technical innovation is appropriate for our research project. The key factors mentioned in this research question are investigated on the macro-economic level, the meso-economic level and the micro-economic level. Therefore the research project is splitted in four parts, as can be seen in figure 3.1. Each part has its own research question.

The first part contains an investigation into the concept of 'technical innovation'. First aim of this part is to get to know which topics innovation, technological innovation and technical innovation include. The second aim of this part is to point out several characteristics of innovation that are relevant to our research. This is formulated in a research question:

> (ii) *What definition of technical innovation and its characteristics are appropriate for our research?*

The second part of the research project contains the macro-level research. The macro-economic level contains factors that play on the national as well as the international level. In this part it is pointed out what factors at the macro economic level are present and how they influence innovation. Of course, these factors will appear to be different for Japan and the Netherlands. The specific research question for this part is set to:

> (iii) *What are important forces in society that support or inhibit innovation on the national and international level?*

The aim of the third part of the research project is to search for factors in the relationship between enterprises and their environment which influence technical innovation. These relations play at the meso-economic level. Enterprises are grouped into divisions based on similar output activities. A lot of divisions exist. Our research is confined to divisions, in which electrical engineering plays an important role. The research question that is put at this level for the selected divisions is:

> (iv) *Which fields of Electrical Engineering are of interest in the division and what are hot innovation topics in that division?*

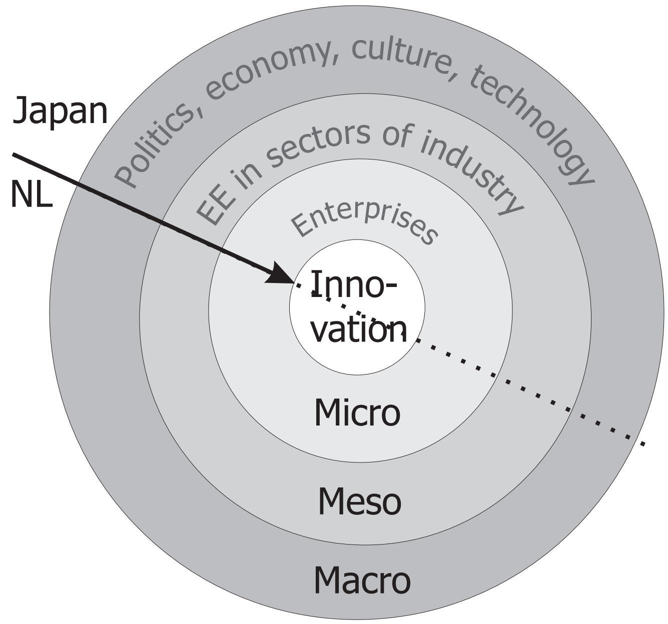


Figure 3.1: Model of the research project

The fourth part of the research project contains a micro-level investigation. The aim is to find out which factors play a role in companies, universities and institutes, and if the factors that play at higher economic levels influence technical innovation at the micro level. This is formulated in the following research question:

(v) *What factors support or inhibit technical innovation on the organizations' level?*

3.4 Realization of the project

The four parts of research are depicted in figure 3.1 in which every shell corresponds to one part. The research project was performed by several lectures, presentations and assignments. First the core concept of the research project, technical innovation, is made clear in the theme survey. Then, this concept is approached from the outside passing through the three levels. The macro and meso level research are performed in parallel, after the theme survey. The theme survey, the macro-level and the meso-level research were preliminary to this tour. Thus, the preliminary report of the study project contained the results of the first three parts of the research project, in order to prepare both participants and companies that hosted us.

The fourth part, the micro-level research, is based on company visits in both the

Netherlands and Japan. The visits in Japan form the main part of the study tour that took place in November 2004. This final report presents the results of this micro-level research and our final conclusions.

Additions to the research project

In addition to this research set-up, participants were encouraged to attend the lectures by prof. dr. Stam on 'Organization and management in Japanese Enterprises'. Another addition to the research project was a course on the Japanese language in which most participants participated. This course was one of the cultural preparations to the tour.

Support

The activities within the research project were supported by the scientific staff of the faculty of Business, Public Administration and Technology, especially dr. S.J. de Boer of the Technology Development Group and prof. dr. J.J. Krabbendam of the Technology and Organization group (T&O). The relevance of this research project to our participants, who are Electrical Engineering students, is recognized by the department of Electrical Engineering: the courses that are part of the research project have been fitted into the Electrical Engineering curriculum of the participants.

3.5 Part outline

The research part of the final report consists of chapter 3 to 6. In chapter 4 the results of the preliminary research are briefly mentioned. Chapter 5 then contains the micro-level research results including conclusions on the visits. The reserach part is completed with the final conclusion and a few recommendations in chapter 6.

The contents of these chapters are made by the participants. The succesive authors are mentioned before their texts.

Chapter 4

Preliminary report abstract

In this chapter, an abstract of our preliminary research is given for convenience. The preliminary research of Shouraizou contains a survey on technical innovation and a study of the environment at both macro- and meso- economic level, in which innovation takes place. Correspondingly, in the first section of this abstract the reader is introduced briefly to the concept of innovation as it was used in the project. The second and third section reflect an abstract of respectively the macro- and meso economic environment. The last section of this chapter summarizes briefly our preliminary conclusions.

4.1 Technical innovation

Innovation is more and more recognized to be important for our future. The purpose of the study project Shouraizou is to obtain a better understanding of innovation, by looking at technical innovation in Japanese society and industry and comparing this to the situation in Dutch society and industry. In order to get this better understanding, the following research question was put: "What definition of technical innovation and its characteristics are appropriate for our research?"

Technology has a number of meanings, varying from 'products' to the various disciplines of science and engineering. Technology development is the outcome of activities of human beings and thus sensitive to culture. Innovation means 'to make new, to renew or to alter'. The concept can be separated in two parts: development and diffusion. Innovation can be found in both product and process developments. This survey on technical innovation contains both development and diffusion, but is confined to products and processes as far as they involve technological advancements. Innovations can take on many shapes and forms, be it a new technological breakthrough, a refinement of an existing technology, or the application of a technology to create a product. Technological changes are described by an s-shaped curve in which the emergence phase and the incremental phase are distinguished.

The environment in which innovations take place consists of three levels: the general (or macro-economic) environment, the industrial or competitive environment (or the meso-economic level), and the task environment (or the micro-economic level). At the macro-economic level political, economic, social-cultural, technological, geographical and historical actors can be distinguished. At the meso-economic level institutions can be classified along two dimensions: private versus public institutions, and institutions that develop versus institutions that facilitate. Both levels were investigated in the preliminary report.

In order to create a good micro-economic environment for technological advancements, institutes have to define a technology strategy. A main input factor for determining a proper technology strategy is the environment at all three levels. Technology strategy is the revealed pattern in the technology choices of firms. The choices are influenced by the fundamental objective of the firm, its possibilities in the environment and the available resources. The execution of the technology strategy involves the appropriation of certain technologies, the deployment of technology in products and the deployment of technology in the value chain. The organization of technology in firms has had a shift of focus from technology-only to marked-oriented as well. Several organization structures were discussed.

4.2 Macro research

Socio-culture, technology, history and geography

These four sections give a wide angle historical view of Japan. Starting with the tectonics it will show how volcanoes formed the country and how geographical aspects like the location, the shape of the countryside and the geographical location have acted as both advantages and disadvantages on building the current Japanese civilisation.

After geography the history of Japan is summarized. Japan has always been a very closed country and formed a very specific culture. Although they have imported some habits from abroad, like the Chinese writing and Confucianism, Japan has always proven to be able to adapt these habits to their own culture. The Japanese are also very curious towards new technology. This curiosity made Japan one of the most technologically developed countries in the world.

Both history and geography have formed the Japanese culture to what it is today. This culture is very different from our own culture and also the businessculture of Japan is very different from ours. Japanese see themselves as a member of a group (their family, their business) and decisions are made by the group, never as an individual. The mostly male employees usually work their whole life for the same company and a dismissal is such a big shame for a man that he might not return to his family after he is dismissed. Because the Japanese culture differs so much from ours it might be hard to understand the way businesses act.

International economics

The international economy has a great influence on Japan. It contributed to its success and to the cause of its recession. Japan is historically a closed nation, both in culture as in foreign relations. After World War II a new foundation was laid on which it prospered to become the second largest economy in the world. Japan has opened up to some extent and improved its trade relations with the US, Europe and the Asian region.

After decades of miraculous economic growth Japan was hit hard in the recession of the 90s. It is referred to as the lost decade, because the growth in the last ten years is negligible. Major reforms will be carried out in an effort to escape the stagnation and hopes are high that they will be successful. The US have always been a valuable trading partner but in recent years the focus is shifting to the East. Of all the major economies in the world, only China has seen dramatic improvements. If Japan wants to remain a world economic leader it must overcome its historical differences with its neighbor. The Netherlands have seen a large growth in the 90s but is currently in recession.

Free trade and globalization are important to economic prosperity. To realize this, Japan is a member of global and regional trade organizations to combat fraud and stimulate harmonious legislation. The formal trade barriers are almost non-existent, but cultural differences and local laws pose a more elusive barrier that hinders foreign competitors and investors. The Netherlands also exploits the benefits of cooperation in regional and global trade organizations but the Netherlands has few trade barriers.

Japan has a large surplus on its trading and investment balance. The imports and exports changed in nature since 1970, because the share of finished goods in imports has risen to the level of other developed countries. Although Japan penetrated technology intensive foreign markets, the sales of imported precision machinery rivals the domestic sales. Direct foreign investments made by Japan are increasingly done in Asian countries, but investments in the US and Europe are still considerably higher. The Foreign Direct Investments (FDI) in the Netherlands are as high as in Japan, but the inward and outward investments are more balanced. The imports and exports of the Dutch are half of that of Japan, while the Gross Domestic Product (GDP) of Japan is ten times higher than that of the Netherlands.

Japan and the Netherlands both have technology intensive exports with a technology rate as high as one third. Although Japan invests more in R&D, both countries score equal points on the innovation scale. In general innovation is a key element in the international trade of both economies

National economics

The general situation in Japan is that currently the economy is growing, however at a very slow rate. The GDP/GNP currently is growing with 1% a year and this is quite small for stimulating innovation. Interest rates have always been low but are now virtually zero to motivate people to spend their money. The deflation however is inhibiting this effect because money will be worth more tomorrow even with a zero interest level. The lack of demand for product is also inhibiting innovation, but the low interest rate should stimulate companies to innovate since funds are cheap. The Bank of Japan is currently enlarging the money supply to decrease the deflation and maybe even get some inflation and thereby encouraging consumption again. From this the conclusion can be drawn that the economic situation is of strong influence on innovation. Unemployment is also becoming a problem. This causes people to limit consumption since it is uncertain if they will keep their job and thus their income. The income of people with a job has been very stable for the last 30 years and this is a comforting thing for the working class. When we look at the theory of business cycles combined with past developments we can conclude that the economy will pick up and start to grow. From this we can conclude that although the Japanese economy is not doing very well at the moment, it will do so in the future. This will also be a stimulation for innovation.

National politics

After World War II, Japan became a democracy with a similar structure as seen in most Western countries: a parliament (Diet), cabinet and ruler. The government can be seen as a very high prestige company whose job it is to oversee and regulate. Due to this professional attitude Japan in the past thought beyond the conventional ways and employed policies leading straight for improvement and innovation. Nowadays, Japan and the Netherlands are both reducing regulations that hinder companies to innovate. Support is more and more given as competitive support, also pushing universities and institutes to acquire funding from the private sector. The policies of the Japanese and the Dutch governments are alike with regard to these aspects. But in the last decade the contribution of the Dutch government to the national Gross domestic Expenditure on Research and Development (GERD) is decreasing, whereas Japan is trying to increase its contribution. The Japanese contribution to the GERD is lower than the Dutch share. This is even without the increasing support of the EU. The GERD of the Netherlands is about 2% of GDP and, within the EU, the Netherlands have signed an intention to achieve a GERD of 3% of GDP. Whereas Japan, having a GERD of 3% already, is trying to increase it and they are also trying to increase the role the government plays in it.

As with most countries, the environment comes after economy. Both countries show detailed plans of how they want to preserve the environment. Those regulations, like on carbon emissions, nitrate or waste production, can and sometimes do severely limit companies in their capacity to function with maximum economic efficiency and thus innovation. The Netherlands promotes a somewhat more active environmental regulation than Japan.

Corruption can cause several problems on economic, politic and social matters. Innovation can also be hindered by corruption. The Transparency International

CPI indexes the rate of corruption of countries. The Netherlands shows less corruption than Japan. Bureaucracy is an important factor for slowing down the making of decisions and the arranging of things. This can affect innovation in a bad way. Japan and the Netherlands have a slow bureaucracy. Freedom of speech and human rights are important factors of innovation. Freedom of press is on the base of creation of knowledge and innovation. Citizens in Japan and the Netherlands are treated in a right way, with respect to the human rights. The freedom of press is high in the Netherlands and not very high in Japan, but not bad. This statement is based on the second World Press Ranking of Reporters without Borders.

International politics

Both bilateral and multilateral level relationships are important for Japans economic ties and safety, which are important for innovation. The bilateral relations are discussed with the relations with other countries and the multilateral are discussed with the international organizations.

The relationship with other countries has changed during over the centuries. In 1600 the Netherlands already had relations with Japan, but these relations were lost in 1900 through the new foreign policies of Japan. After World War II Japan became dependent on the United States by the Treaty of Peace. This led to an international politics focus of Japan on its economic market and the relations with surrounding countries for trading.

Although Japan is still dependent on the United States for its security and economy, it has become more independent through the years. For resources Japan has become less dependent on Western powers, which can stimulate the production of innovative products.

Japan spends a lot of effort and money in supporting other countries in Asia by joining international organizations like the UN, WTO, World Bank, IMF, Colombo plan and the Asian Development Bank. It also finances organizations like the ASEAN. A reason for this is because Japan is dependent on the raw materials it gets from these nations and the Japanese government therefore wants a stable, peaceful world economic market.

The Netherlands and Japan are trying to repair the relationship between the two countries by supporting and funding organizations that promote companies or opportunities for exports of goods and technology as well as for investment in the both countries.

All these factors stimulate the companies and organizations in both countries to invest and to explore their markets to deploy new innovations. Both governments want their markets to trade and invest in a stable economic market.

4.3 Meso research

This section is an abstract of the meso analysis carried out as a part of the study tour to Japan. Japan and the Netherlands are compared on meso economic divisions according to the ISIC Rev.3.1 division definitions. The five analyzed divisions are:

- Division 31: “Manufacture of electrical machinery and apparatus n.e.c”;
- Division 32: “Manufacture of radio, television and communication equipment and apparatus”;
- Division 33: “Manufacture of medical, precision and optical instruments, watches and clocks”;
- Division 73: “Research and development”;
- Division 80: “Education”.

The divisions have been analyzed with Porter’s Diamond. This model is a powerful and systematic way to evaluate the industry’s ability to be competitive and innovative.

Division 31

Japan and the Netherlands are different, with respect to the situation of the industry in ISIC division 31. The Netherlands shows more innovative activity, but this may change greatly in the future. The export and import are relatively much larger in the Netherlands, due to the fact that the Netherlands is in fact a trading nation. This is good for the development of this division of industry. Japan has an advantage in the higher productivity of its employees. Japan has been compared to the Netherlands, even though Japanese production is about 200 times greater and the Netherlands are EU-wide a small player in this section of industry. A recent innovation which belongs to the electric equipment division is a new type of electric motor. The usage of permanent magnets in these motors results in a high efficiency over a wide speed range. Because of this, this type of electric motor is used in many new applications. Since during the study tour there will be a visit to Showa Shell near Tokyo, a manufacturer of photovoltaic cells and modules, this survey includes a part about solar technology. Currently, Japan is the world’s biggest producer of solar cells and modules.

Division 32

In division 32, mainly the consumer electronics industries of Japan and the Netherlands have been analyzed. The conclusion from this analysis is that the concerned industries in Japan enjoy better conditions to be competitive and innovative compared to the Netherlands. The most interesting field in this division is the consumer video equipment division, which shows very promising growth numbers, especially LCD screens. Therefore, hot innovation topics concern advanced display technologies and these are being developed in Japanese as well as in Dutch companies.

Division 33

Division 33 is the division that includes manufacturing of medical devices, measuring and testing instruments and process control equipment. Some of the findings are that the Japanese government is working very hard to improve the economy, and is therefore trying to stimulate international trade, and that the Netherlands most of all appear to be a gateway for the distribution of equipment. Some hot innovations in this division are a newly developed chip to measure the blood sugar level, the world's first bio-sensor, a virtual reality operating theater, smart sensors and the use of manipulation systems that are based on simple hardware elements performing simple physical actions.

Division 73

Division 73 is the division of research and experimental development on natural sciences and engineering. Japan faces a hard economical climate at the moment, but because government and industry are sensitive for the argument that innovations bolster a country's economic growth and competitiveness, in recent years Japan started initiatives to create innovations. To make it as easy as possible for institutes the Japanese Patent Organization tries to improve procedures and reduce wait time by requesting patents. In Japan, much research and development is done. Besides companies, this work is done by research institutes at a high level. The government gives high priority to research and development and tries to stimulate this as much as possible. They are working hard to get a larger technological advance in relation to the EU or the US. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has three bureaus which are involved in the division research and development. The main problem in Japan is that until now, they focus too much on development. Basic research is not good developed and this could become a problem. Although the Netherlands used to be a leader in innovative products, the Dutch are nowadays just followers and have to be careful not getting too far behind. The Netherlands profiles itself as an innovative leading country, however this is not the case. It is furthermore inevitable that, if the Netherlands continue its current policy, they will get further behind. However, a link has to be created from the basic research to final products and at the moment that link is missing.

Division 80

Division 80 is about education. The main difference between Japan and the Netherlands is that, in general, the level of education in the Netherlands is higher. In Japan, there are almost no universities like the Dutch ones. Most universities in Japan are considered 'HBO' level in the Netherlands with the exception of some national (Tokyo and Kyoto) and private institutions. The Junior Colleges are comparable with ‘MBO’ level in the Netherlands. That is also the reason that it is not very interesting for European students to study in Japan. It may be interesting in a cultural sense but the educational value would not be as high as in Western countries. Furthermore, the Dutch higher education is more involved in technical innovation than Japanese higher education. The reason for this is that student’s assignments on Dutch universities regularly arise from companies in some way. This is quite uncommon in Japan. Although most universities in Japan are private institutions, the Japanese higher education is not very market-oriented and flexible. The national universities have to shift their focus from high standards and status towards competitiveness and market oriented thinking if they want to survive the economy of today.

4.4 Preliminary conclusions

In the preliminary report we made up a few conclusions based on the survey on technical innovation, and the survey on the macro- and meso economic environment. These conclusions do not take our findings at the micro-economic level into account. These are found elsewhere in this final report.

The research question was:

> *“What are key factors that influence technical innovation in Japan and the Netherlands?”*

We found that culture has a high influence on innovation. Three main aspects stemming from culture are: people’s enthousiasm to grasp opportunities, the level of appropriation of technology developments and the quality of communication lines between persons.

An economic key factor is the ability for companies to sell innovative products. This is related to market size and economical climate. The market size is determined by the number of consumers on the served markets and by the willingness of people to buy latest technology products which again has roots in culture. The economical climate is fluctuating in both countries, however, in Japan it is fluctuating for a longer time.

Also important for innovation is the level of knowledge transfer, which takes place for instance when people switch jobs. Job-hopping is more common in the Netherlands than in Japan, which is a difference that stems from culture. Political factors that influence innovation influence the scale of the output markets, both national and international. The amount of market pull research performed at institutes and universities, for instance in cooperation with private companies, is an other important factor that influences innovation. This market pull research returns investments on a short time since they are directly sold in products.

Chapter 5

Micro research results

Chapter contents

5.1 Introduction

by Michel van Dijk

In this chapter the results of the micro research are presented. During the macro and meso research attention was paid to the (inter)national environment of organizations. Micro research on the contrary, focuses directly on the companies, institutes and universities regarded. The term companies, institutes and universities is regularly used and is therefore abbreviated CIUs.

The micro-level research question that is answered in this chapter is:

> *What factors support or inhibit "technological innovation" on the organizations' level?*

The organizations that are regarded in the micro research have been divided in the groups listed below:

- Division 31: Electrical machinery and apparatus;
- Division 32: Radio, television, telecommunication;
- Division 33: Medical, precision and optical measurements systems;
- Philips and Sony;
- Division 73: Research and Development;
- Division 80: Higher Education;
- KIVI NIRIA congress.

Division 31 through 33 and 'Philips and Sony' contain the companies, division 73 contains the institutes and division 80 contains the universities. The last group describes a congress about innovation held by KIVI NIRIA. This congress has been included in the micro research since it provided useful information on the topic of innovation. The companies have been divided into several divisions because this makes it possible to compare companies within a division. Moreover, a group containing all the companies would become very large and inconvenient. Since a useful division is already available from the meso reseach, this division is used here as well. Philips and Sony have not been included in one of the divisions because these two companies are quite similar and it was useful to make a one-on-one comparison between these two.

The micro research has been carried out by six groups. Each group has been assigned several CIUs in both Japan and the Netherlands. Information about the Japanese CIUs was collected by research done before the study tour to Japan and by visits to these CIUs during the stay in Japan. Information about the Dutch CIUs was collected by visits and the contract research assignments carried out by the participants.

The following sections each consider one of the divisions described above. Each section starts with a description of the CIUs that fit in the division belonging to the section. Then a discussion follows in which the CIUs are compared to each other. In order to structure the comparison, all gathered information is put under ten innovation-issues as much as possible. These topics are: core technology research, management structures, in- and outsourcing, spin-off enterprises, environment, technology push versus market pull, sustaining versus disruptive technology developments, allocation of resources, modular and integrated design and the acquisition of knowledge and intellectual property.

Although the CIUs have been divided in divisions so that they fit together it is still not always possible to make good comparisons. This is because CIUs with the same activities still can vary enormously in size and business policies. Each section ends with a conclusion concerning that specific division. The research question that is answered in these conclusions is:

> *What are the characteristics of innovation in practice in the CIUs and to what extent do these characteristics match with the results of the macro, meso level and innovation research?*

This chapter is finished with a section containing conclusions for the entire micro level research. Here, the most important and noticeable remarks from the subconclusion are taken together and an answer to the micro research question is given.

5.2 Division 31: Electrical machinery and apparatus

by Bert van den Berg, Matthijs Krens, Sebastiaan van Loon and Dirk van Schaijk

There are three companies regarded in the micro research that belong to division 31. These companies are discussed in this section, they are:

- Capital Turbines;
- Spark Design Engineering;
- Showa Shell Sekiyu K.K.

5.2.1 Capital Turbines

The relative young international company Capital Turbines started in 2000 to become a world class energy service provider. In four years it has grown rapidly around the world and now consists of nine offices in different countries with plans to open another one in China by 2005 [6].

The company top is Capital Equipment Enterprises Ltd. (CEEL), beneath this board is Capital Turbines with its corporate office in Perth (Australia) where a solid staff coordinates and realizes all projects. The other offices are situated in different countries and they are sales and representative offices. On project basis personnel is hired. This gives the company a flexible environment and makes it capable to undertake different kind of projects and to use new technologies. The technology knowledge is acquired through strategic alliances with companies and international organizations [7].

The capabilities of Capital Turbines are all aspects of the power generation business, from small equipment supplies to major turnkey Engineering, Procurement and Construction (EPC) contracts and ongoing operations and maintenance services. With the alliances with Pratt & Whitney Power Systems, Turbine Air Systems and Nordic Wind Power, Capital Turbines is focusing on international clients in the power generation area.

Some basic data about Capital Turbines can be found in table 5.1.

Innovation process

Capital Turbines is a relative young enterprise and was founded from CEEL. The innovation process is not as visible as with most research and development companies. It has no R&D department and the core technology of Capital Turbines is the power generation market. They scout the market for new potential technologies. With these potential technologies the company offers a wide range of services to its costumers. The organizational structure is mainly sales with basic

Company name:	Captal Turbines
Founded:	2000
Number of employees:	10
Turnover:	$50M
Head office:	Australia
Main operations:	Power generation, equipment supply, turnkey EPC contracts, operations, maintenance
Main relationships:	Pratt & Whitney Power Systems Turbine Air Systems Nordic Wind Power

Table 5.1: Basic data Capital Turbines

engineering on project basis. Their services are supported through their network of formalized "strategic alliances" with international organizations. For example with the case study of coal gasification a choice had to be made which gasification process was needed to offer the best solution for their customer. With this Capital Turbines looks for a company where it can buy the technological licenses for using that specific technology. With these licenses a contractor is hired to build or install the equipment. The technology research as well as the implementation is outsourced to specific companies.

New governmental regulations (for the energy market) provide Capital Turbines the possibility to work on new innovative projects and sell services for environmental issues. For example in the case of coal gasification the research started through the Kyoto protocol that was signed by 186 countries [8]. This protocol forces countries to regulate the emission outputs (like CO_2 and NO_x) of the power suppliers. Pulverized coal combustion systems (which are commonly used for power generation with coal) have a lot of polluting emissions. Power plants with natural gas are relatively cleaner, but the price of this fuel is rising and makes it more expansive to use. To get a clean fuel out of coal and to get an even higher efficiency, new innovative technologies are needed. So this governmental regulation stimulates new innovative technologies to develop. Capital Turbines is focusing on the expanding Asian market and the USA. They finished several projects in these areas with success.

For the development of new products and services, Capital Turbine looks at the market. The demands of the customer are very important. Although Capital Turbines looks for new services to put on the market it still delivers on customers demand which makes it a market pull company. As stated by Capital Turbines in their Statement of Capabilities brochure [7]: "We strongly believe that honesty and integrity are the cornerstones of any long term business relationship, and we equally strongly believe that while gaining a client may be relatively simple, retaining a client depends on understanding the client's motivation and interest, and working to continually provide innovative and cost effective solutions which meet or exceed the client's objectives for the contract."

The technology used by Capital Turbines is mostly sustaining technology. They depend on strategic alliances and these companies do not often offer disruptive technologies. The resources of Capital Turbines are allocated by the global organization structure of the company. With this international network of sales and basic engineering offices it is possible to connect different markets and services around the world to international or national customers in the power generation field. With an open and modular design the products and services are flexible enough to answer the demands of customers. The products and services comply with the international standards (like the quality management system of ISO 9000:2000 and the Safety Management System Australian Standard (AS) 1470-1986) and employees follow different courses to keep themselves up-to-date.

5.2.2 Spark Design

Spark Design is an engineering consultancy formed by a fusion in 1997 of NoorderBreedte design consultancy (Delft est. 1992) and Vici Product development ('s-Gravendeel est. 1994).

As an engineering consultancy Spark can take care of the entire design of a new product or act as a soundboard for the marketing department and almost anything in between. Client range in size from SME's to large Multinationals. These services are made possible by a staff of 17 engineers with a flair for design and designers with interests in engineering.

The office of Spark Design is located in Ridderkerk where they have workspaces with CAD and a workshop to make physical models to better communicate the design to customers and for better fine-tuning of the design. Besides being able to complete the entire design for a new product they can also take care of funding, patents and any other obstacles included in the process right up to the actual production process. Even economic and technological feasibility studies are possible.

For designs and production Spark also has strong ties with a broad panel of specialists including materials, component and electronics suppliers, universities and technical colleges, mould makers, prototype makers, marketing and communication consultancies, standards institutes, ergonomics (human factors) consultants and patent agents.

Examples of products designed and/or managed by Spark are The Carver, a crossing between a car and a motorbike, several rehabilitation products, a digital handheld recorder and the Fresh brew unit for professional coffee machines [9].

Some basic data about Spark Design can be found in table 5.2.

Company Name:	Spark Design Engineering
Founded:	1997
Number of Employees:	17
Turnover:	
Head Office:	The Netherlands
Main operation:	Product Ideas and Concepts, Styling and Design, Project Management, Prototyping
Main relationships:	Patent agents, materials etc suppliers, universities, prototype makers

Table 5.2: Basic data Spark Design Engineering

Innovation process

As a designing consultancy Spark is very innovative. Its main purpose is to create new products for their customers. While some innovations will be improving an existing technology others involve making an entirely new product. In creative brainstorming sessions with the client, key product characteristics are established by asking questions such as: What must the product have to succeed? What should it look like? What working principles could we use? Next, using sketches, models and explanations, a selection of fresh and innovative ideas is presented. These ideas are then tested and worked out one by one. From this process of natural selection the first design concept evolves. If a possible solution for a successful product involves technology in which Spark does not have expertise itself, other companies are contacted to work out smaller portions of the design.

Another thing Spark does is to make sure a new product can become an innovative success. This is done by a technological and an economic feasibility study. The technological feasibility study determines if the product can live up to the current standards and is easy to mass produce and the economic feasibility study is used to determine if the product can be made and sold at a profit.

The products that Spark Design makes are determined by their client and therefore it cannot be said that Spark is mainly active in sustaining or disruptive technology.

5.2.3 Showa Shell Seyiku K.K.

During the study tour the Central Research & Development Laboratory of Showa Shell Sekiyu K.K. [10] in Japan has been visited. Here Shell is working on the CIS solar technology. The main focus of Showa Shell Sekiyu K.K.is on petroleum products, but other focus points are New Technologies like the CIS.

The lab was established in 1966 under the name ARL. The lab was bought by Showa, which became Showa Shell Sekiyu K.K.

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Showa Shell Sekiyu K.K. was established in 1985 through the merge of Showa Oil Co. Ltd. and Shell Sekiyu K.K.. Showa Oil Co. Ltd. was originally established in 1942 through the amalgamation of the companies Hayama Oil, Asahi Oil and Niitsu Oil. In 1949, Showa Oil signed an agreement with the Royal Dutch/Shell Group for the import of crude oil and the exchange of technical know-how [10]. In table 5.3 the basic data of Showa Shell Sekiyu K.K. is given.

Company Name	Showa Shell Sekiyu K.K.
Founded	1985
Employees	1031
Turnover	$310 Million
Head office	Diaba Frontier Building 2-3-2 Daiba Minato-ku Tokyo
Main operations	The sale of petroleum products and development of environmentally friendly energy alternatives by the Central Research Laboratory
Main relationships with other organizations	The Shell Petroleum Co. Ltd. Japan Trustee Service Bank, Limited Shell Japan Holdings B.V

Table 5.3: Basic data Showa Shell Seyiku K.K.

Traditionally, the research was in the field of oil-related products. A small part of the central research laboratory is doing research on photovoltaic technology. This part is subsidized by the government and is actually independent of the rest of Showa Shell. The central laboratory has a strong background in Chemical Engineering and most of its research is in the area of lubricants and fuel in close cooperation with Showa Shell. Some new technologies developed at the institute are bioremediation, hydrogen generation and of course photovoltaic devices.

Electrical Engineering

The central research laboratory is doing research on different fields. The photovoltaic technology was the goal of our visit and will therefore be explained in this section. The technology used to fabricate these panels is Thin Film Technology. This technology consists of several processes to deposit thin layers of materials (several microns or smaller) on a substrate like glass or silicon. Several examples of deposition methods are Plasma Vapor Deposition, Chemical Vapor Deposition, sputtering, etcetera. Solar panels, or also called photovoltaic applications, can be seen as a division of Thin Film Technology as depicted in figure 5.1.

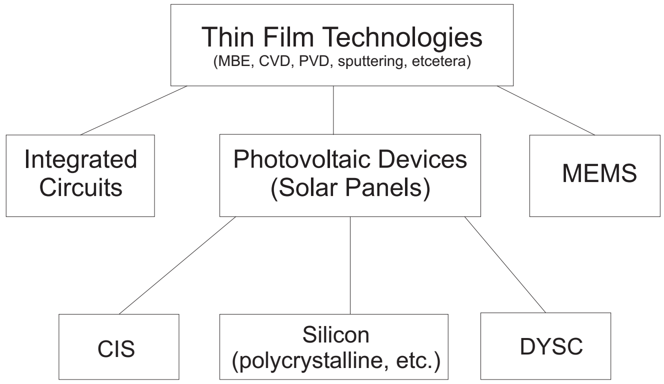

Figure 5.1: CIS in thin film technology

Photovoltaic material is a semiconductor that generates free electrons when exposed to light. When these electrons are properly gathered, a potential difference may be produced. A typical solar cell is formed out of several specific layers (substrate, back contact, absorber, buffer layer, window layer, top contact grid and anti reflection coating, of which the absorber layer is the photovoltaic material [11]). To create these layers on top of each other, several Thin Film deposition techniques are required. Problems that arise during the fabrication process (during deposition) are the diffusion of one layer in another, crystalline defects and the adhesion of the layers. Because several layers have to be deposited on each other, low deposition temperatures are needed, to prevent diffusion of the previous deposited layers. For a high quality solar cell, the absorber layer has to absorb as much light as possible, sometimes mirroring effects are used to trap the light in the solar cell.

A promising new type of material for photovoltaic applications (solar cells) is copper indium diselenide (CIS). CIS can be deposited in several ways [12]. The deposition technique used is mostly the prohibiting factor when it comes to marketing. Expensive machines are needed to create the thin layers and most machines are product specific. Furthermore, the dimensions of the solar cells are often much smaller in the lab and not suitable for production.

Innovation process

Today the Japanese solar cell market is dominated by Sharp, Kyocera and Mitsubishi. The main component of their cells consists of polysilicon. If this market is to survive, the production capacity has to be scaled up [13]. The bottleneck for this specific technology is the price of silicon wafers, which are used as substrates for the solar cells. CIS can be deposited on cheaper materials like glass. This also has an advantage with respect to the cells' sizes, silicon wafers have certain dimensions, glass substrates can have larger dimensions.

Shell Solar Japan has been able to increase the panel size using the CIS technology. The panel size has now reached commercial size. For the substrate layer glass is used, making the material cost for a single solar panel cheap compared to the conventional (more expensive than glass) Silicon substrate. These CIS Thin-film solar modules are the only modules based on thin-film technology competitive to crystalline Silicon Solar modules. The energy efficiency is comparable, making the CIS Thin-film Solar Cell low cost with high performance. The material used has high adsorption. This is also showed by the black appearance of the cells; all incoming light is absorbed. Showa Shell has simplified the production process needing fewer steps.

The laboratory thinks that the market will be dominated in 2030 by CIS solar cells, because of their higher performance and lower production costs than polysilicon cells. Also, continuous production is possible as opposed to batch production for polysilicon cells and the production energy is very low.

For space applications crystalline (not polycrystalline) silicon solar cells are used. However, CIS Thin film Solar Cells can compete with these cells as can be seen in 5.4 with much lower production costs.

Technology:	CIS Thin-film Solar Cell	Conventional crystalline silicon Solar Cell
Cell efficiency @ 15cm x 15cm:	14-16%	15-18%
Thickness of deposition layer	3μm	300 μm
Production	Simple production process, with less steps	More steps
	Low cost High performance	More expensive silicon

Table 5.4: Comparison of solar cells for space usage

In the past Japan has been struck by two big energy crises, one in 1973 and one in 1979. These were mainly due to the dependence of energy on the external market and the inability to generate energy internally. Since the last crisis the energy production is strongly controlled by the government. The New Energy Development Organization (NEDO) is a government organization and it funded the research on the CIS cells by the New Sunshine Project that ran from 1993 till 2000. Due to the Kyoto Protocol Japan needs to reduce its CO_2 emission by 6 percent compared to the CO_2 emission in 1990. However due to economic growth the CO_2 emission has only grown. Compared to the CO_2 emission of the year 2002 a reduction of 13.6% is needed to reach the Kyoto goal (in 2008).

The government is therefore subsidizing the research on alternative energy resources for a large amount. The Japanese government is clearly stimulating innovations, however there is a counter side. The factory we visited was already able to mass-produce the CIS cells in small quantities, so the production technologies are thought to be at the end of research. The main problem to introduce this new technology to the market lies in the ties with the government. At completion of their research, the institute has to surrender all information and research results of CIS to NEDO. Also, venture businesses are prohibited and need consent from the government, due to the way the CIS project was funded. This makes it difficult to find large investors for mass-production. It must be said that other projects at the facility, opposed to the CIS project, are done in cooperation with Shell and other institutes.

The reason for starting research on CIS technology were government regulations and investments: This makes CIS technology a government initiated market push and can be considered a disruptive innovation, if it hits the market: at first CIS solar cells will be more expensive than conventional silicon solar cells, but we expect this will soon change when the CIS cells are mass produced in larger quantities.

Shell's organizational structure has 5 core businesses. These businesses are placed under different companies and divisions where all shares from those smaller businesses are owned by larger sections. The different businesses share knowledge with other companies and institutes. Only in the case of the CIS-project knowledge transfer is prohibited due to the ties with the government. After completion of the research NEDO can be asked for the use of the knowledge. This can also be done by other companies or institutes, depending on NEDO's consent.

Showa Shell is one of the 3 leading companies in the world in the area of CIS technology. The other two are Shell Solar industries USA and Shell Germany, which are independent companies using different technologies. Showa Shell is particularly proud of the thin-film technology they use to produce such thin layers. Showa Shell uses a unique Zink-Oxide layer, which they have developed themselves. The CIS film was tested on a satellite, where it had the highest durability. So this seems an important innovation. Another interesting aspect is the fact that they do not use Cadmium as the other two companies do, which makes this technology more environmentally friendly.

Context characteristics

Before visiting the research facility, we looked at the information available online about Showa Shell Seyiku K.K. and the other research centers in the Shell Renewable division. This information showed that Shell Renewable was set up in the Netherlands, Germany and Japan. These are also the three countries that give government funding to research on solar panels. This, combined with the information that said the main manufacture and research was done at the site in Germany, we expected a very small scaled research center in Japan that would look at certain aspects of the manufacture of solar panels. We also expected that this research center would have close connections to the research centers in the Netherlands and Germany and a lot of communication between the centers. We also expected a large portion of this research to be funded with government funding.

5.2.4 Discussion

As already mentioned in the introduction of the micro research it sometimes can be difficult to compare companies within one division. The activities differ quite a lot and therefore some important aspects of the different companies are only summarized, not making a direct comparison. It has to be stressed that Showa Shell is the only one doing actual research.

Technical research

The research center of Showa Shell is doing all its research with regard to the CIS-technology within the company. Knowledge sharing will however take place in other divisions of Showa Shell. Spark Design is a consultancy company and other companies can buy their expertise. Capital Turbines has no R&D and all their technology is bought at other companies.

Management structures

The organizational structure within Showa Shell is divided into different levels, whereas the two Dutch companies act on a more equally basis.

In- and outsourcing

Spark Design and Capital Turbines are used for outsourcing by other companies. Showa Shell does not use outsourcing and is doing all of its research and development within the laboratory. When Spark Design and Capital Turbines do not have the needed knowledge themselves, they will outsource it.

Spin-off enterprises

It is not likely that consultancy companies will generate spin-offs. Showa Shell is a big company and also generates spin-offs. However, within the CIS-project Showa Shell is not allowed to generate a spin-off without the consent of NEDO.

Environment

Like many companies in Japan, Showa Shell is very formal compared to Dutch companies. Dutch companies have a more open structure, making it possible for employees to generate new ideas. If we look at the two Dutch companies, we note that they are very small and will therefore operate on a more equal basis.

New governmental regulations (for the energy market) provide Capital Turbines the possibility to work on new innovative projects and sell services for environmental issues. The same kind of regulations had a positive influence on the CIS research, funding most of it.

Technology push versus market pull

Showa Shell is doing independent research to CIS technology subsidized by the government and is prohibited to trade this knowledge with other Shell groups without the consent of NEDO. The product will in the end be competing with other solar panel manufactures. This makes CIS technology of Showa Shell a government initiated market push. Although Capital Turbines looks for new services to put on the market it still delivers on customers demand which makes it a market pull company. This is the same for Spark Design, that is doing assignments on company's request.

Sustaining versus disruptive technology

The technology used by Capital Turbines is mostly sustaining technology. They depend on strategic alliances and these companies do not often offer disruptive technologies. Spark Design makes products on demands of other companies and creates no technology. Showa Shell's CIS technology can be considered a disruptive innovation, once it hits the market, since it will probably replace current solar cell technology.

Allocation of resources

The resources of Capital Turbines are allocated by the global organization structure of the company. With this international network of sales and basic engineering offices it is possible to connect different markets and services around the world to international or national customers in the power generation field. Showa Shell has the resources in house to manufacture and test their CIS technology in small amounts. Spark Design creates new products for companies linking manufacturers and suppliers together.

Modular and integrated design

Capital Turbines uses an open and modular design so the products and services are flexible enough to answer the demands of customers. Showa Shell's CIS Technology is a modular design that is easy to connect and tune to customers needs. Spark Design always meets the design requirements of customers so a modular or integrated design is dependent on the customer.

Acquisition of knowledge and intellectual property

Showa Shell buys its knowledge by taking over complete companies that have interesting research going on. Capital Turbines buys licenses to obtain new knowledge and Spark design has a core staff for the main activities and outsources any activities it does not have the knowledge for.

5.2.5 Conclusion

The three companies that were studied are very different and have very different organizations. Showa Shell is the only company doing active R&D creating new technology, so this would seem the most innovative company. On the other hand Capital Turbines maintains its position in the market by innovating the way they organize the international business network. Spark Design is also innovative in their field of industrial design and organizing the entire route from the start of the design until the point of production. Based on this, we can say R&D does not necessarily have to be a key element for a company to innovate, new technologies can be acquired in different ways. The following cannot be concluded from our investigation, but new technology is necessary for new innovations. It may be a dangerous situation when a company is dependent on external resources of new technologies. Primary research gives a company a strong foundation to innovate.

As for Showa Shell, we expected a closer tie with the main Shell Company. We thought that Shell bought the research facility to acquire new technologies. This may be the case or not, when we went to Showa Shell Sekiyu K.K. we found out that opposed to our expectations there is virtually no communication between their research center in Japan and the research centers in the Netherlands and Germany. Also the research center was not just researching some aspects of the CIS solar panels but the entire process of how they work and how to manufacture them efficiently. This also meant the CIS research project was larger than we expected. Moreover, we expected the research to be funded by government funding and funding coming from Shell Renewables but instead it is completely funded by the Japanese government. After completion of the project, the results go to NEDO. This makes the CIS project an innovation, initialized by the government. After completion of the project, NEDO has an influence on which companies are allowed to use the technology. This may give Japanese companies an advantage over international companies; it is not certain that Shell will produce the CIS solar cells. It may also inhibit spin-offs and the spreading of the new technology. The government funding results in a paradox: CIS research is motivated, but the marketing of CIS cells is slowed down.

5.3 Division 32: Radio, television, telecommunication

by Casper van Bethem, Bertjan Davelaar and Thomas Janson

There are four companies belonging to division 32 discussed in this section:

- NTT Basic Research Laboratories;
- Asahi Kasei Microsystems Co, Ltd;
- Mitsubishi Electric Corp;
- Versatel Telecom International N.V.

5.3.1 NTT Basic Research Laboratories

About 100 scientists in the Basic Research Laboratories at the Atsugi Location in Kanagawa Prefecture are engaged in fundamental research. BRL in its present form was established in 1998 when the former BRL was divided into Communication Science Lab and the basic research labs. The Basic Research Lab is part of NTT Science and Core Technology Laboratory Group. The final goal is to create innovative approaches for the telecommunications technology of the future. For enhancing such research activities, NTT BRL intensively promote exchange of information and researchers with outside organizations based on an "open door" policy. Besides other NTT laboratories, various scientific exchange programs are runned with Delft University, Stanford University and the University of Tokyo. Moreover, NTT BLR holds International Symposiums, Summer Schools and International Advisory Board Meetings to disseminate the research information worldwide and encourage greater understanding of it.

Company name:	NTT Group
Year of foundation:	1952
Number of employees:	3.056 (March 2004), (205,288 employees on a consolidated basis)
Turnover:	¥11.095.500 million (March 31, 2004)
NTT Basic Research Laboratories	
Location:	3-1, Morinosato Wakamiya Atsugi-shi Kanagawa 243-01 Japan
Main operations:	Basic research on telecommunication related topics
Main relationships:	NTT Group

Table 5.5: Basic data NTT Group

Organization

NTT Research and Development consists of three research divisions. The NTT Cyber Communications Laboratory Group, NTT Information Sharing Laboratory Group and the NTT Science and Core Technology Laboratory Group. The three groups have respectively 500, 1500 and 1000 people at work. The NTT Science and Core Technology Laboratory Group consists of five laboratories; Network Innovation Laboratories, Microsystem Integration Laboratories, Photonics Laboratories, Communication Science Laboratories, and the Basic Research Laboratories which we visited.

Mission

NTT develops many new concepts. The mission consists of three targets:

- Research and development in cutting-edge technologies that will expand NTT groups' fields of business in the next 5-10 years;
- Foundation of new principles and concepts revolutionizing all aspects of information technology;
- Research and development in technology that have a low impact on the global environment and human beings.

Electrical Engineering

In the following text, some research by several laboratories will be brielfy presented.

Research Areas & Flow of NTT Science and Core Technology Laboratory Group

To achieve "broad band services" for even easier information sharing and "ubiquitous services" for rich information sharing anytime and anywhere, NTT will uncover net IT possibilities through futuristic communications and networks, photonics and ubiquitous technology, and science as a foundation of these core technologies.

Network Innovation Laboratories

This laboratory works to develop stress-free user interfaces that allow users to work with information obtained from a number of sources. Furthermore, they are working on building network services that are capable of autonomously adapting to many different environments. The Network Innovation Laboratories developed a Super High Definition (SHD) Digital Cinema distribution system with the resolution of eight million pixels that is able to store, transmit and display movie digitally. The image quality is equivalent to that of 35mm movie film.

Microsystem Integration Laboratories

A portable environmental sensor capable of automatically measuring extremely toxic BTX gases even at very low concentrations, anytime, anywhere with high sensitivity, has been developed. It is applicable for on-site environmental monitoring and health assessments. A system for the automatic generation of photorealistic 3D computer graphics (CG) from glossy, translucent, or objects of varying complexity has been developed. It can be applied to many areas including digital archives.

Photonics Laboratories

The tunable laser array (TLA) consists of 8 or 16 DFB lasers, a MMI coupler, and a SOA. The wavelength tuning can be easily achieved by temperature or injection current control. In optical communication systems, integrated circuits (ICs) are key components that enable many kinds of required signal processing. This lab has developed ultra-fast ICs operating at 100 Gbit/s by making the most of lnP-based crystal growth techniques, minute transistor fabrication techniques, and high-frequency circuit design techniques. Currently, lnP HFET and HBT ICs for more sophisticated signal processing are studied and developed.

Communications Science Laboratories

A blind source separation method based on Independent Component Analysis (ICA) has been investigated. This technology can blindly identify three or more sound sources. This kind of identification is difficult for humans. Communication Science Lab investigates the dynamics of the human vision system and its ability to distinguish amongst colors, and developed a new image processing method to simulate color-appearance of human under various illuminant environments. This lab also conducts theoretical research on auction theory, in particular, on the possibility of fraudulent activity enabled by the anonymity of the internet. A series of auction protocols have been developed, in which honesty came out as the best policy. This is to say that acting dishonestly is not rewarded and participants voluntarily refrain from engaging in fraudulent activity.

Basic Research Laboratories

Silicon single electron devices can manipulate individual electrons and will enable the future fabrication of silicon integrated circuits with extremely low power consumption and high functionality. Quantum bits or qubits that use the principal of quantum mechanics enable extremely high speed calculations. Combined with nano-fabrication technology and biology, new sensing devices have been explored. It has been predicted that the semiconductor diamond is the best device material with high power and high frequency performance. In collaboration with Ulm University in Germany, the alb has succeeded in fabricating high-performance FETs.

Innovation process

The innovation process at NTT Basic Research Laboratories is described below.

Technology research

Technology Development Policy

The mission of Science and Core Technology Laboratory Group is to establish NTT core competence by creating cutting-edge technology for expanding business areas, uncovering new principals and concepts for revolutionizing IT, and developing technology easy on people and the global environment. To fulfill this mission, NTT will research and develop basic and core technologies bases on a medium-to-long term (5 to 10 year) outlook for breaking down barriers in network and communication technologies on the three levels of futuristic communications and networks, photonic and ubiquitous technology, and science.

Future communications and networks

NTT Science and Core Technology Laboratory Group is striving to create technologies that will bring a revolution to telecommunications by braking both the "communication barriers", which have to do with safety, ease of use, richness in content, freedom, language, culture and the physical senses, and the "network barriers", which have to do with speed, bandwidth, reliability and adaptability.

Photonic technology and Ubiquitous technology

The research and development of the NTT Science and Core Technology Laboratory Group focuses on two kinds of devices for supporting futuristic communications and network: optical devices, with photonics as the core competence; and devices for ubiquitous services, such as electronic devices with advanced functionality.

Science

The goal of this area is to establish new principles and create new concepts. They are pushing ahead with research on communications science, including human media processing and human information science, and on quantum information processing technology, including single-electron devices and quantum computers based on nanostructure technology.

Business Operations Policy

- Promotion of business-oriented core research;
- Dissemination of strategic information;
- Promotion of search-oriented core research;
- Promotion of open systems;

- Raising of cost/product consciousness.

NTT BLR emphasizes the need for good communication between researchers and managers as a way to judge whether basic research will bear fruit in the future or not. Alongside exploratory research, NTT BLR puts effort into creating innovative technology. For instance, in the field of diamond semiconductors, whose ability to handle high-power and high-frequency waves makes them promising for various applications, NTT BLR has developed technology that produces diamond thin films of high quality and succeeded in operating a diamond transistor at 80 GHz. There are more examples of projects, which NTT BLR sees as innovative technologies to overcome the limitations of the present network.

Spin-off enterprises

When a new technology seems to get somewhere, it is transferred to the division within the company to which it is most related. This is not a guarantee that there are totally no spin-off enterprises, but NTT is a very diverse company and the impression exists that the number of spin-offs is very low. All the technology is kept within one company as much as possible.

Technology push versus market pull

This subject was only drawn to our attention at the photonic lab. At the photonic lab, research is very basic. So for the technology developed there, customers have to be found, although there almost always some interest in advance. So this is clearly technology push. The customers have to be found, while the technology is ready. Because NTT does a lot of basic research, it's presumable that most developed technology is technology push driven.

Allocation of resources

The R&D expenditures at NTT have decreased recently. However, this development can be seen in many companies in this sector. The holding company includes R&D and income of the holding company is decreasing. Because of decreasing income, R&D expenditures also have to decrease.

Acquisition of knowledge

To maintain fruitful research activities it is essential to have an open research policy, according to NTT BLR. Besides close contact with other NTT labs, NTT BLR runs various scientific exchange programs with institutes in- and outside Japan. Furthermore, within the company there's a lot of communication and publishing. Hundreds of papers a year are published and NTT gives thousands of presentations a year about its activities. There is not much information available about this subject, but people can certainly be up-to-date by reading each others papers and visit presentations. By reading papers of other companies, people also can acquire knowledge.

NTT BLR provides employment opportunities and invites professors and researchers to conduct fundamental research and enhance international relationships. As one of the most experienced host companies in Japan, about 20 research associates (post doctoral fellows), professors, and trainees are present at any time, exchanging research ideas and developing research collaborations. Its strong technological foundation, large funds, latest research facilities, and fully experienced management facilitate this goal. The NTT Basic Research Laboratories encourages skilled scientists and engineers who are ambitious, cooperative, and interested in electrical and electronics engineering, physics, chemistry, material science, and related areas.

5.3.2 Asahi Kasei Microsystems Co, Ltd. (AKM)

Asahi Kasei Microsystems (AKM) is a worldwide leader in CMOS mixed-signal ICs for the personal computer, professional audio, consumer electronics, automotive, and cellular phone industries. AKM is a subsidiary of the Asahi Kasei Corporation, a diversified technology, manufacturing and service company.

Company name:	Asahi Kasei Microsystems Co, Ltd.
Year of foundation:	1983
Number of employees:	850
Shareholder:	100% Asahi Kasei Corp. (AKM is a consolidated subsidiary of Asahi Kasei Corp.)
Turnover: (Asahi Kasei Corp.)	¥1.253.534 million (March 2004)
Design & Development Center	
Location:	Atsugi AXT Main Tower 20F 3050 Okada, Atsugi-shi Kanagawa-ken 243-0021
Main operations:	IC design and development
Main relationships:	ARM Ltd.(32 bit RISC microprocessor technology), NexFlash Technologies Inc. (Serial Flash EEPROM technology)

Table 5.6: Basic data AKM

Asahi Kasei Microsystems (AKM) has based its corporate operation and development in two fast-growing areas vital to the growth of information and communication systems, custom and application specific LSIs (Large Scale Integration ICs). This has led to world leading design and process technologies for high quality, low power consumption products for communications and multimedia applications, in a range that now includes analog-digital mixed circuit ICs for mobile communications equipment, A/D and D/A converters based on Delta-Sigma self-calibration technology, and data storage ICs incorporating lossless data compression and error correction technology.

AKM was founded in 1983 as Asahi Microsystems Inc., a joint venture of Asahi Kasei Co. and AMI of the United States. When, in 1986, Asahi Kasei acquired the remaining shares of Asahi Microsystems, the name was changed to Asahi Kasei Microsystems Co., Ltd. AKM is part of Asahi Kasei EMD Co., which itself is part of the company Asahi Kasei Co. The Design and Development Center of AKM was visited during the study tour.

Electrical Engineering

AKM focuses on the following fields in LSI ICs.

Wireless Communication

AKM has earned a reputation for outstanding analog-digital mixed signal technology, securing a leading share of the world market for mobile communications ICs. AKM products featuring high performance, high integration, and low power consumption are used in a broad range of cellular and cordless phone applications. Development is ongoing for next generation products which meet the emerging needs for greater speed, performance, and precision in mobile communications.

Wired communication

Chips which enable reduced packaging space and decreased noise are essential to meet the growing demand for smaller, higher performance communications equipment. AKM offers a variety of products for a wide range of applications, including transmission equipment, Central Office exchange system, PBX/KTS, and ISDN, featuring AKM's outstanding analog-digital mixed signal technology and low power consumption. Leading communications companies throughout the world have chosen to employ AKM products, recognizing that they provide the best long-term solutions.

Audio

A higher level of voice processing performance is expected for cutting-edge multimedia applications. AKM's high performance digital audio products have proven to meet these expectations, and are used in multimedia applications throughout the world. AKM is supporting the advancement of next-generation digital audio performance through the development of products which meet the needs for low power consumption, high quality audio solutions with its delta-sigma and self-calibration technologies backed by vital experience and know-how.

Image processing

AKM's rich variety of image processors for image scanners, FAX machines, digital copiers, and multi-function peripherals meet a wide range of high-precision, high-resolution image processing needs. The lineup also includes video ADCs for high-pixel-count CCDs, ADCs for high-speed signal conversion, and ICs with NTSC/PAL signal processing inputs and outputs. AKM's cutting-edge image processing ICs are expanding the possibilities for development of new, high performance multimedia equipment.

Data storage

The spread of the Internet is rapidly expanding the need for high-capacity, high-speed data storage systems. With its world-leading high-speed analog CMOS and lossless data compression core technologies, AKM provides products for a wide variety of storage systems. With a reputation for performance and reliability, AKM is extending its leadership in this field through the development innovative new products.

Crystal oscillator ICs

Main clock modules of digital cellular and digital cordless phones conventionally require several discrete parts, including a thermistor as a temperature sensor, and a variable diode as an oscillator. Analog Temperature Compensated Crystal Oscillator (TCXO) ICs from AKM provide a compact, 1-chip solution that meets the need for clock modules, as portable handsets become progressively smaller.

Memory specialties and Sensors

AKM employs the most advanced technologies and systems available, for the design and development of special memory ICs (mainly EEPROM) that meet the ever-increasing need for higher-level integration, noise margins, endurance cycles, and speed, reduced size and power consumption, and small-lot, large-variety production. It is recognized both at home and abroad, as a world leader in product development time and product quality. AKM also develops a diverse amount of sensors, for various applications. An example of a very popular sensor is the flip sensor, which is used in mobile phones to register if a flip type mobile phone is open or not.

Custom ICs

AKM responds quickly and effectively to the needs of domestic and overseas customers, in a broad range of designs and variations, based on its wealth of design experience, CMOS analog-digital mixed IC development capability, and total CAD system. Its development techniques and comprehensive capabilities are most clearly typified in the system-on-a-chip solutions of its full-custom ICs.

Innovation process

Technology research

The research done at the Design & Development Center is mainly product focused and thus little basic research is being done. Therefore AKM is also more into sustained technology development.

AKM is developing their GUI (Graphic User Interface) software for designing chips by means of the CAD group. A more common procedure in this industry is buying a software bundle for this matter. An advantage of in-house developed software is the reduced time spent on problems with software. Another big advantage is the specialised software, because this is completely adapted to the type of products that AKM produces. Furthermore, the expenses for their home developed software are less than that of a bought software package. On the other hand, a negative point of this specialised home developed software is their poor ability to adapt fast to the complete new design of chips. So, disruptive technology developments in the concerning branch could cause a technology-level set back for AKM. Therefore, they are currently studying whether to use a commercial software bundle or stay with the current strategy.

Although AKM has products for certain applications that are top notch in the industry, their sole goal is not just to make a limited products with the best possible specifications. In some situations it is better to have a more diverse product catalogue with somewhat less performance. For instance, when a big company is interested in using the chips in their products it is sometimes better to be able to sell more different chips than just one type, so AKM can sell them a bigger package. This could mean not only chips for a CD player, but also for DVD players, amplifiers, etcetera. So, AKM is also focusing on diversification of their products, besides tuning up performance.

Management structures

The Design & Development Center in Atsugi is responsible for all technology development of AKM. In this Center the following groups are located:

- Design Group;
- Test Group;
- CAD Group;
- Design assistance Group;
- Quality assurance Group, Atsugi branch.

Within the Design Group, three persons work on the design of a chip, under supervision of a team leader. This team leader has more of these teams to look over and is also responsible for the composition of these teams. The members of each team have a meeting together once weekly, also all team leaders consult each other once a week. The tasks or ideas are brought by the team leader to the team members (designers). When a designer has a different idea about a certain thing, this is free to be discussed with his or her superior. Nevertheless, our notion is that ideas mainly come "top-down".

The design of one chip takes about 4 to 6 months, after which it is sent to the production facilities in Nobeoka, Japan. After 6 weeks the samples are sent back and will be tested by one of the team members. The other two of this team will take part in other projects.

In- and outsourcing

AKM seeks and works closely in technological alliance with leading experts and organizations at home and abroad. Its engineers participate globally in leading scientific and technological symposia to keep their knowledge up to date.

Environment

Employees mostly come from universities after a master study, mostly native Japanese from all over the country. Students are brought in by writing to various universities when a suitable position within AKM is vacant. The few foreign employees at AKM are mostly positioned at the software division. This is because speech recognition for car use is developed there, which naturally concerns different languages. AKM believes that its working culture is slightly more European or American than average Japanese companies, maybe because of the American origin of the company. Despite of that, most things in this company go by the "top-down" principle, according to AKM. "Bottom-up" is certainly allowed, but probably the people don't tend to do so because of their nature.

Technology push versus market pull

AKM develops their products mainly market pulled. Higher integration, low power consumption, less chip area and lower cost are specifications customers demand for.

Sustaining versus disruptive technology development

AKM works mainly on sustaining development of products. Disruptive technology improvements are rare, although AKM cooperates with other parties like universities, domestic and abroad, for the research of new technologies.

Modular and integrated design

AKM is more into modular design, primarily because of the products that are products are not consumer ready products. The products of AKM are used together with other components to form end products.

Acquisition of knowledge

The engineers of AKM participate globally in leading scientific and technological symposia to keep their knowledge up to date. Also, employees of the design department sometimes go to the factory to see how things are produced and what's possible in designing from production view. "Job Rotation" is possible, but occurs rarely within the AKM Design & Development Center. AKM rather lets their employees get a lot of knowledge in one area, instead of letting them obtain knowledge in many different areas. The latter option assumed better for personal development of employees, but generally slows down the development speed of products.

AKM welcomes information sharing. This means that they are willing to share their knowledge with partners, but this is sharing should be based on giving and taking. The balance between receiving and supplying knowledge is dependent of the negotiating position. Because AKM is not a very large company, this position can sometimes be not that strong as AKM would wish. On the other hand, when a new technology is discovered, AKM patents it when they think it is promising.

5.3.3 Mitsubishi Electric Corp.

Mitsubishi Electric's principal activities are to develop, manufacture and distribute electronic and electrical equipment for industrial, public and personal use.

Mitsubishi Electric started in 1921 as a spin-off from Mitsubishi Shipbuilding and firmly established itself as a diversified electric equipment manufacturer, nowadays branching into nearly every sector related to electric equipment. In 1946, all Mitsubishi companies turned independent under the post-war government policy of decentralizing industry. The independence of the Mitsubishi companies makes the "Mitsubishi Group" all but impossible to define meaningfully. A convenient definition is the membership of the Mitsubishi Kinyokai, or Friday Club. That group comprises presidents and chairmen of 29 Mitsubishi companies. They meet informally for lunch on the second Friday of each month.

During the study tour the Advanced Technology R&D Center was visited, which supports every division in Mitsubishi Electric, developing basic technologies in areas such as electrical equipment, machinery, new devices, energy, the environment, new materials, system solutions, image monitors and displays.

Electrical Engineering

Energy & Electric Systems

This division includes power generation equipment (turbines, transformers etc.), monitoring systems, elevators and escalators. For instance, the company is devel-

Company name:	Mitsubishi Electric Corp.
Year of foundation:	1921
Number of employees:	98.988
Turnover:	¥3.309.651 million (March 31, 2004)
Advanced R&D Center	
Location:	8-1-1, Tsukaguchi-honmachi Amagasaki City Hyogo 661-8661 Japan
Main operations:	R&D in a diverse range of fields such as electromechanics and laser technology, electronic device technology, energy, environment and wellness technology, and materials technology.
Main relationships:	Mitsubishi Electric Corp.

Table 5.7: Basic data Mitsubishi Electric Corp.

oping high-speed inclination sections for high rise escalators. This revolutionary high speed escalator travels much faster in the inclined section than at the entrance and exit, which substantially speeds up transport over long vertical distances while ensuring greater safety. Also, Mitsubishi has developed spirally inclining escalators, which can for instance be found at the lower floors in the "Yokohama Landmark Tower". This is the highest building in Japan, located in Yokohama, and we visited it during the study tour. Concerning elevators systems, variable-speed elevators will help shorten waiting and riding times. When at half its carrying capacity, this finely tuned traction machine optimizes the balance between elevator car and counterweight to increase speed beyond its official rating, while ensuring a safe ride. Escalators and elevators are strong branches within Mitsubishi. Currently China, Hong Kong South Korea and Taiwan account for a large share of the sales for this division. On the other hand, the United States is scarcely represented in these sales.

Also new security instruments are developed in this department. An example of new technology in this area is a non-contact fingerprint scanner. This fingerprint registration device can work without actual contact with the finger being scanned. On top of that, it is less sensitive to modification of fingerprints due to the non-contact type scanning method.

Industrial Automation

Within this division, car electronics, robotics, logic controllers, circuit breakers are being developed. For instance, Electronic Toll Collection equipment (ETC) allows drivers to pass through toll road collection gates with a cashless payment system. Onboard ETC units and ETC equipment for tollgates employ Mitsubishi Electric’s leading wireless and semiconductor technologies, which contribute to safe and smooth road travel.

Information & Communication

Mobile handsets, wireless and wired communication, medical systems, but also aircraft electronics and fire control systems are examples of what is created in this division. One of the products is Connexion by BoeingSM. Connexion by BoeingSM is an epoch-making system that realizes high-speed broadband communications in the cabins of flying aircraft, providing passengers with e-mail and video services. This is made possible by Mitsubishi Electric’s satellite communications technologies.

Electronic Devices

The division “Electronic Devices” includes micro electronics, optical devices and LCD displays. An example of new technology is a LCD screen with significant better response time, which it obtains by predicting the next frame that will be projected. Another example is an LCD screen with different image for the left and right eye, which results in a stereoscopic view. Furthermore, important new production methods for nano-electronics are being developed in this division at the Advanced Research & Development Center. An important one is the use of x-ray for lithography for production of wafers. Lithography by means of light is in the near future incapable to support the demand in decreasing IC sizes. Therefore, Mitsubishi is researching x-ray lithography, which has the properties to handle a further miniaturization of ICs.

Home Appliances

Examples of products of the division “Home Appliances” are: consumer audio and video equipment, air conditioning systems, washing machines, freezers, and etcetera. The highly advanced air-conditioning systems include the Lossnay energy recovery ventilator, which can ventilate without changing the room temperature.

Innovation process

Technology research

The company focuses its research and development efforts on honing the competitiveness of its principal businesses in line with its two growth strategies. This is a strategy that concentrates attention at certain terrains in research and development, because Mitsubishi doesn't want to become too diverse. Under the VI Strategy, Mitsubishi Electric aims to strengthen the growth potential of individual businesses and to further distinguish itself in the competitive businesses of elevators and escalators, factory automation equipment, automotive electric and electronic components, satellites and others. Under the AD Strategy, Mitsubishi Electric aims to create solutions businesses, such as environmental and energy management system solutions and integrated security solutions, combining a variety of technologies related to two or more business fields.

Management structures

In the Advanced Research & Development Center the rough planning comes from the board, further details are fulfilled at lower levels. Mitsubishi Electric's IP promotion activities, further described under the subsection "Acquisition of knowledge", are managed at its headquarters under the direction of the President and at the individual IP sections designated for the respective business groups. Headquarters formulates strategies, addresses critical issues, files applications, and licenses patents for the entire company. Each business group works to execute its individual IP strategies.

In- and outsourcing

Mitsubishi tends to develop all knowledge in-house, so outsourcing is almost zero. Also, facilities are not shared with other parties.

Acquisition of knowledge

The results of research and development efforts are shared widely as intellectual assets within the company to improve development efficiency. Mitsubishi Electric also promotes the acquisition of intellectual property rights that are associated with its business and development strategies. The company concentrates on acquiring intellectual property rights with global applications and strives to develop standards based on these patents to bolster the competitiveness of its operations. Mitsubishi Electric promotes the utilization of knowledge gained from around the world through its R&D activities; joint initiatives with cutting-edge research institutions in Japan and abroad; participation in national projects; and collaboration among industries, government entities, and academic institutions. Mitsubishi Electric Group recognizes its intellectual property ("IP") as vital management resources for the development of its business and integrates its business and R&D activities with its IP activities. The company owns approximately 35,000 patents and files about 8,000 applications every year in Japan and overseas for a portfolio of competitive patents around the world. Mitsubishi Electric's IP policy focuses on creating intellectual property that strengthens its business competitiveness.

The company aims to bolster its strategic IP practices by designating critical themes for important company-wide business projects and major R&D projects. As a crucial element of future business competitiveness, the aim is to turn their technologies into international standards, and the company is redoubling efforts to patent technologies that become part of such international standards.

The acquisition of overseas IP rights is also a critical element to the globalization of their operations, and such IP activities are coordinated among the overseas operational bases, research centers and affiliated companies. Mitsubishi Electric is now focusing on bolstering their activities in China. As part of the efforts to prevent infringement of intellectual property rights, the company is taking rigorous measures to exterminate counterfeits by working closely with relevant industry associations and government agencies. The goal is to increase internal awareness of how to manage trade secrets and prevent the outflow of technologies by formulating company rulebooks and having them distributed to all employees. Through these measures, Mitsubishi Electric Group is strengthening its IP practices worldwide to underpin its operations deployed all over the world.

5.3.4 Versatel Telecom International N.V.

Versatel Telecom International N.V. is a telecommunications company that primarily focuses on the Dutch, Belgian and German market. Versatel owns an extensive telecommunication network that uses the latest technologies to provide business and residential customers with voice, data and internet services.

Versatel was founded in October 1995. Currently, the company has over 1 million customers and approximately 1,700 employees. In addition to the core activity of providing broadband telecommunication services to business customers, Versatel founded Zon, an Internet Service Provider that plays an important role in the growing market of residential Internet services in the Netherlands. Versatel's objective is to become the leading fully integrated, alternative provider of broadband services, voice, data and internet services, to customers in its target market.

Versatel's high bandwidth network has been designed and built to provide flexible, broadband local access to major business customers and population centers in the Netherlands, Belgium and Germany and to certain international destinations. The network carries voice, data and Internet traffic and supports all major protocols, including Frame Relay, Asynchronous Transfer Mode ("ATM") and Internet Protocol ("IP"). Versatel connects with the major Internet exchanges in Amsterdam, Brussels, Frankfurt, Berlin, London and Paris and has increased the number and quality of peering arrangements with carriers of IP traffic to enhance its presence in the rapidly expanding European Internet services market.

Company name:	Versatel Telecom International N.V.
Year of foundation:	1995
Number of employees:	1700
Turnover:	€462,1 million (2003)
Location:	Hullenbergweg 101 1101 CL Amsterdam (head office)
Main operations:	Versatel offers fixed telephony, data, internet and mobile telephony services to business customers and consumers. In addition, Versatel offers network services to other telecommunication companies.
Main relationships:	Versatel competes with other telecom providers. It provides services to business customers and other telecom providers. Versatel relies on equipment manufactured by e.g. Cisco and IBM

Table 5.8: Basic data Versatel

Innovation process

Technology research

Versatel operates in a consumer-driven sector. Still, Versatel is continuously developing new products, such as Triple Play (combined voice, internet and video service). Most of all, Versatel wants to employ new technologies as soon as they are effective and available. Versatel is continuously improving its network by expanding their backbone and local access infrastructure. The network is designed to be highly scalable, so that Versatel will be able to reach millions of users. The network is also highly flexible, so it can support IP telephony. This makes WiFi telephony a new possibility.

Management structures

Within Versatel, short- and long-term development is separated. Versatel's R&D division initiates network developments and major product developments that will be important for Versatel in the long run. The R&D division closely cooperates with other Versatel divisions for planning and design to implement the new concepts.

In- and outsourcing

Versatel has been working together closely with suppliers of equipment such as Cisco and Nortel for a long time, in a relation that can be described as a partnership. But now more other companies are cooperating for development. For the corporate market, an increasing number of products are being developed in cooperation with partners. Versatel has a division dedicated to this purpose.In the past, Zon Internet B.V. was founded by Versatel and the national radio station Radio 538. Since 2003, Zon Internet is fully owned by Versatel and it will be renamed to Versatel Internet.

Spin-off enterprises

Versatel does not have any spin-off enterprises. Versatel has been consolidating and integrating acquisitions and subsidiaries into the company. Most subsidiaries are mostly or completely owned by Versatel.

Environment

In 1996, the Dutch market for telecom was opened to the public domain. Since then, there have been many developments, but these did not come from the government. The government has a passive approach in this sector and only takes action when things get out of hand. And even though the market is "open", the incumbent operators (KPN) often make the rules, which in some cases delays new technologies. Several government subsidies exist, but Versatel chooses not to make use of them because of related obligations and drawbacks. Regarding Dutch people, Versatel believes there is an interesting side-effect of the Dutch relatively informal way of communicating. Every Dutch employee wants to communicate their opinion and wants things done their way, which can slow things down, according to Versatel.

Technology push versus market pull

In general, improvements on existing technologies are initiated by the Marketing division, which can be seen as market pull. Major new markets however, are mostly created by technology.

Sustaining versus disruptive technology development

Versatel continuously improves it services and tries to extend their network coverage. Versatel does introduce technologies that change the rules of engagement. For example, TV over ADSL will be a serious threat to existing cable-tv companies and will undoubtly disrupt this market.

Allocation of resources

Versatel plans to continue to invest in the areas where they have been successful and in new areas where their customers have indicated a need for innovative services. For 2004, the key priorities were the further roll-out of the existing IP-VPN services to new customers and increasing the DSL footprint in Germany and the Netherlands.

Modular and integrated design

Considering design, this subject is not very relevant to Versatel. Of course flexible and scalable networks are important to Versatel. The use of an IP-VPN network has proven to be important for Versatel. This can be described as a tendency toward modular.

Acquisition of knowledge

Versatel does not own patents, but having knowledge and expertise is considered of great importance. Versatel prefers to not directly buy knowledge, because it creates unfavorable dependencies. Having knowledge makes the company able to fend of competition.

5.3.5 Discussion

In this section differences and similarities between these CIUs are presented.

It is important to realize that the activities of the companies are very different. While AKM is very active in the design of high-tech ICs, NTT BRL is doing research on subjects one would expect to see at a university. Mitsubishi makes new, revolutionary appliances, while Versatel develops network services. The research is done on various levels, and the time to market varies widely. But the main goal is always to create valuable knowledge for the company.

Technology research

NTT and Mitsubishi are doing research that will lead to products after several years. NTT BRL is the only one not doing applied research, but this is only because the NTT subsidiaries do this kind of research. On the other hand AKM is the Japanese company which is the most applied research oriented of all.

Management structures

In all companies, there appears to be a clear separation between short-time-to-market applied research and long-term research or concept development. It is interesting to see that the basic research in NTT is done in NTT BRL, which is part of the holding company itself, and not within each subsidiary of NTT. Perhaps the subsidiaries are considered to be expendable, so not suited for long-term investments, or NTT as a whole is better manageable this way. Mitsubishi separates its research because they have two different growth strategies that can roughly be divided in tangible products and solutions.

In- and outsourcing

Even though there are several examples of partnerships and other relations, there are no clear cases of outsourcing, except for the trivial supply chain. All concerning companies seem to strive more or less to independency, in which Mitsubishi appears to be most eager to do so.

Spin-off enterprises

These companies rarely or never spin off other companies. This is probably because these companies consider consolidation of resources and ownership a good thing. New technologies have usually been used for products within the company.

Environment

Lack of informal communication can sometimes cause new ideas to be never uttered. There is a notion that Japanese companies tend to have less informal communication than Dutch companies. According to AKM, communication within their company is primarily “top-down”, but confirmation of this notion for the other companies within our division has not been found. People at AKM say that the working culture of AKM is more European or American than average Japanese companies. In other words, AKM tends to have more informal communication than other Japanese companies, but this is probably still less than companies with a Western origin. According to Versatel, communication in Dutch companies can be too informal and people can slow down the process of decision-making, and thus innovation. Furthermore, all companies work more or less together with universities and other companies in various ways, because they believe this can have important benefits.

Technology push versus market pull

The companies of course improve their products when there is demand for this. However, NTT BRL is doing the most basic research of all, and is very technology push oriented. On the other side, we see AKM which is very market pull oriented, simply complying with increasing demands. Naturally, Versatel is looking at the customer’s demands, but they attempt to introduce completely new services. All companies we regard here have a desire to be able to operate technology push oriented, but they are actually more or less market pull driven.

Sustaining versus disruptive technology

Disrupted technologies may be created in all companies, but we see that NTT BRL is most active in this area of the concerned companies in this division. However at this moment, all the revenues appear to originate from sustained technologies. This of course is only true if we consider mobile telephony to be a sustained technology, as in the case of Versatel.

Modular and integrated design

Modularity is mainly relevant to AKM. In the field of LSI, modular design is unavoidable. For most companies modular design is required up to a certain level. For instance: a telecom network consists of several, individually operating components.

Acquisition of knowledge

NTT and AKM appear to be very willing to exchange knowledge with the right partners. In these two companies there is also active stimulation towards employees to enhance their knowledge. Mitsubishi seems focused mostly on collecting and profiting from knowledge. They are working hard on keeping knowledge in house, acquiring IP rights and setting standards. An important factor here is the size of Mitsubishi compared to the other companies. Mitsubishi Electric is a very big company, so it is easier for them to set standards and work on their own than it is for instance for AKM. Furthermore, their amount of knowledge is also greater. More information can thus be found within the company, which results in relatively less exchange of knowledge with other parties. Versatel also wants to keep knowledge in the company, but does not have patents.

5.3.6 Conclusion

All companies in this division consider innovations as an important source of creating new value and a way to keep up with the competition. This includes that companies are continuously improving their products and production processes, to match market and customers demand. On the other hand, we see a very diverse view to market strategy. NTT BRL is quite technology push oriented, and AKM and Versatel are mostly market pull driven.

There is a notion that Japanese companies have less informal communication and a more "top-down" information stream than Dutch companies, but the only confirmation of this notion in our division was within AKM. On the other hand, AKM is more Western-like than other Japanese companies and thus has more informal communication than its native colleagues, according to people at AKM. So, although there is no hard data on this, there is a sense that other Japanese companies are even more "top-down" oriented than AKM. Versatel believes that informal ways of communicating like it is present in Dutch companies can sometimes slow down progress.

Furthermore, it can be seen in this division that all Japanese companies seek contact with other companies or institutions. The least open in this matter is Mitsubishi Electric, which is very keen on securing patents and protecting their knowledge. Due to their size, they are able to apply this strategy and focus on knowledge within a huge company like Mitsubishi Electric is naturally more inward. The Dutch company Versatel does not own any patents but considers the way knowledge is handled inside the company to be very important.

5.4 Division 33: Medical, precision and optical measurements systems

by Joost de Klepper, Jasper Klewer, Mathijs Marsman, Martin Schepers and Bart Spikker

Division 33 compromises most companies of the micro research. The companies in this division are:

- Toshiba;
- Horiba Ltd;
- Hitachi PERL;
- Matsushita Electric;
- OITDA;
- Thales;
- Strukton systems;
- Texas instruments;
- Océ.

5.4.1 Toshiba

Toshiba is one of the best known companies in Japan. It was established in 1875 by Hisashige Tanaka, the current President and CEO is Tadashi Okamura and the headquarters are settled in Tokyo. Toshiba, a world leader in high technology, is a diversified manufacturer and marketeer of advanced electronic and electrical products, spanning information & communications equipment and systems, Internet-based solutions and services, electronic components and materials, power systems, industrial and social infrastructure systems and household appliances. Under its mid term business plan for fiscal years 2003 to 2005, Toshiba is working for enhanced recognition as a highly profitable group of companies, active in both high growth and stable growth businesses.

Toshiba, a world leader in high technology, is active in three key domains: the high growth domains of digital products (PCs and related equipment and peripherals, mobile phones, AV equipment, including digital and flat panel TVs, and portable personal equipment) and electronic devices & components (semiconductors, electron tubes, optoelectronic devices, LCDs, batteries, printed circuits boards, etc.) and the stable growth domain of infrastructure systems (industrial apparatus, power generating equipment, transportation equipment, social automation equipment, telecommunication systems, broadcasting systems, elevators & escalators, medical systems, etcetera). Other businesses include consumer products (digital home products and home appliances, etcetera).

The company has a tradition of achievement. In almost 130 years of operation, Toshiba has recorded numerous firsts and made many valuable contributions to technology and society. The company is today the world's 9th largest integrated manufacturer of electric and electronic equipment, has some 161,000 employees worldwide, and enjoys consolidated annual sales of over $53 billion.

Toshiba's management system, assures strong strategic leadership while locating responsibility for operations with executive officers heading at each business. This focus and transparency supports the company in maintaining. Its long-standing commitment to excellence in all it does, and in executing today's measures that will assure sustained growth in the future.

Since its establishment in 1989, the Toshiba International Foundation (TIFO) has focused on promoting initiatives that increase international exchange for understanding of Japan and contribute to society on a global level. TIFO donates funding and services to overseas-based universities and research institutions for the study of Japan, assists international exchanges at museums worldwide and encourages activities aimed at enriching local communities. All activities are related to Japan or Japanese culture in some way.

Company name:	Toshiba
Founded:	1875
Number of Employees:	161,286
Location world headquarters:	Tokyo
Turnover:	¥5,579,506 million
R&D Expenses:	¥336,714 million

Table 5.9: Basic data Toshiba

Electrical Engineering

Toshiba is active in a variety of different fields in the electronics. Products on which they do research on are:

- Compact direct methanol fuel cell;
- Medical robot / Robot technology;
- Carbon dioxide absorbent;
- DNA chip;
- Image recognition chip for automotive applications;
- Speech translation;
- Nanopatterned media;
- Recycling of different materials;
- Ultra-compact real random number generator.

An example of innovation is the development of the HD DVD in corporation with several other companies. There is a need to extend the capacity of the DVDs which are used nowadays. The TV screens resolution is increasing, so to utilize this higher resolution for the same length movies more capacity is necessary. Some companies always want to have maximal improvement of the product, like in this case the capacity of the DVD. Sometimes this is not always realistic because of certain restrictions in physical and/or financial way. The companies of HD DVD decided to increase the capacity not maximal but to keep all the necessary modifications and financial consequences minimal so the price will not raise much.

Innovation process

Toshiba is putting a lot of effort into innovation which is visible in their slogan: they name themselves "Towards the Innovation Driven Company". It even received the TMC Labs Innovation Award 2004 for the Toshiba's SoftIPT SoftPhone, which empowers mobile office workers to take their office phones with them on any laptop or PC anywhere there's wired or wireless connectivity.

To be an innovative company Toshiba strive to create new products and systems that enrich the quality of life and invigorate society: "Turning knowledge and inventions into forms that serve the needs and aspirations of individuals and society is what innovation is all about". This vision is guided with three keywords:

- Delight and surprise: to realize what seemed impossible;
- Safe and sound: people can feel save and sound in the ever-changing world;
- Ubiquitous expertise: linking the ubiquitous stockpile of expertise to the engines of human creativity.

According to Toshiba there are two different kinds of innovations, namely technology innovation and market innovation. Technology innovation is innovation in new technologies which don't have to be directly visible to the costumer. Market innovation is more innovation towards the costumer and can embrace different aspect as new products to new promotion of products. Innovation is difficult because of the shift which takes place at the moment:

Empowerment (hardware)	→	enhancement (software)
Analysis	→	synthesis
Forecast	→	will

To enhance innovation they:

- enhance intellectual output, like collaboration with universities and companies worldwide;
- try to integrate and fuse technology together to create new products;
- acquire knowledge from different fields trough network;
- have the will to lead human society in a given direction;
- enhace the extraction and usage of knowledge from cyber/internet space.

Technology research

Toshiba carries out both basic/advanced and current business-contributing research and development to achieve continuous growth. Their focus is also on creating new businesses by innovative research and development. Their efforts in Research & Development have given them the tools to develop high quality and relevant new applications and technologies.

Toshiba is readying itself for further growth, and has reaffirmed its basic strategy of introducing advanced strategic products offering technological innovations that create new markets.

From the total annual budget Toshiba spends 10% of this to R&D. This resource is spent to different fields where fundamental research gets about 18%. Money also flows towards new business, near future and next generation R&D. The main goal of R&D is to explore the unexplored fields and create technologies for a paradigm shift.

Management structures

Innovation of Toshiba is guided trough a certain organization structure. On top of the organization there is the board of directors, president & chief executive officer. They lead all the divisions in Toshiba as well as the "Technology & Intellectual property group". This group contributes to innovation.

There are several planning divisions to guide T&I, the "Technology Planning Division" and the "Intellectual Property Division". Besides these Toshiba has it own "Corporate Research & Development Centre", which has R&D centres in several places in different countries. The R&D division has an office to make the "road maps" for the company, this office is called the research planning office. They decide e.g. the strategic planning.

The R&D management is not only top-down structured, but also bottom-up. This way not only management has input to the subjects for R&D, but also the employees (mostly young researchers). Toshiba has an internal program to stimulate bottom-up input, to stimulate young researchers to come with new ideas.

This is done for example with the help of meetings. To get employees which are suitable for their company they also collaborate with universities. Top-down management are led from long-term technology and standardization.

Spin-off enterprises

After the R&D phase technologies and knowledge is put out trough new business. This is realized by spin-off companies, an in-house company, a group company or by licensing.

Twice a year the management and researchers discuss for every product or research activity what will be done with it in the future: whether they develop the technology further, they setup a spin-off company or they decide not to go further with the activity at all.

Environment

To realize the paradigm shift, Toshiba collaborates with universities and give young scientists the chance to do research in new ideas. Besides this reason they have project in which they collaborate with other companies, like the HD DVD and the research to MRAM. The 'MRAM'-project is not only done together with NEC, but is also partly financed by the government.

Technology push versus market pull

New ideas for new products mainly come up from the demands on the market. Because of the basic research done by Toshiba, they also have products which are pushed by technologies (technology push).

Sustaining versus disruptive technology developments

Toshiba knows several R&D centres. Every centre is active in its own field which is strongly correlated with their products. Mainly local R&D centres develop sustaining technology and the central R&D division develops disruptive technology.

Allocation of resources

As said before Toshiba is not only dependent on the profit and turnover of the company itself. Some projects are partly paid by the government.

Modular and integrated design

Toshiba is more focused on integrated design, because it develops mostly complete package products. On the other side they do have products like the DNA chip, which is not an integrated designed product. This chip is for sale to other companies, who can make their own product with this chip.

Acquisition of knowledge and intellectual property

Like most companies in Japan, Toshiba protects some of their inventions with patents. Also they work on new standards, like the standard for HD DVD. Toshiba also remarks that not always the standards are decided by the company. Sometime the costumer decides which product/standard becomes successful.

5.4.2 Horiba Ltd.

In 1953, Horiba was founded by Dr. Horiba who was looking for a job. Nowadays, Horiba is a global company with departments in Japan, Europe and the US. Horiba is a global leader in advanced analytical and measurement technology. The goal of the Horiba Group is to produce instruments and systems with high quality and performance standards across a wide range of industrial sectors, including IT, medicine, engine testing and development, environmental monitoring and analysis, biotechnology and power utilities. Horiba Group instruments and systems also contribute to heightened progress in R&D and technical innovation.

Horiba is committed to doing its part to help preserve the environment with advanced analytical technologies developed to deal with these serious global issues. Horiba Group operations are divided into six core segments, being Engine Measurement, Environmental Analysis, Medical, Semiconductor, Biotechnology and Sensors [25]. During the study tour the Engine Measurement Division of Horiba has been visited, which is located in Kyoto.

Some basic data about Horiba can be found in table 5.10. The main focus of the departments in Japan is on production technology, in Europe on elemental technology, and in USA on advanced technology of software. The role of the headquarters, located in Kyoto, is to control the different businesses all over the world. The corporate philosophy is characterized by five points:

- Company Precept: Joy and Fun!
- Business Operation: Utilizing the core competence of each group company;
- Customer responsiveness: Horiba as an ultra quick supplier;
- Responsibility to shareholders and investors: Proper distribution of profit;
- Employees: Open and fair.

As mentioned before, the Engine Measurement Division of Horiba has been visited during the study tour. Its main operations are manufacturing and supplying to industries utilizing internal combustion and turbine engines [24].

Electrical Engineering

Some major electrical engineering topics of the engine measurement division of Horiba are mentioned in the text below.

Company size:	38 group companies
Founded:	1953
Number of Employees:	3,808 employees globally
Location world headquarters:	Kyoto
Turnover:	¥78,501 million
R&D Expenses:	¥4,044 million
Engine Measurement Division	
Company size:	11 group companies
Number of Employees:	500
Location:	Kyoto

Table 5.10: Basic data Horiba Ltd.

The measurement and analytical capabilities of Horiba products play a major role in the development of new automotive technologies, such as cleaner exhaust systems and fuel cells, helping to lower the harmful impact of cars on the environment. Horiba’s engine emissions analyzers are contributing greatly to the development of low-emission, fuel-efficient engines being carried out by car manufacturers worldwide. Moreover, the company’s air pollution monitors and equipment for measuring acid rain play increasingly important roles in finding solutions to pressing environmental problems that have captured worldwide attention.

An example of this is the development of a exhaust emission analyzer, which started in the seventies when there was a big rise in air pollution in Japan. The Japanese government asked Horiba to develop exhaust gas analyzers.

Horiba manufactures and markets to automotive maintenance centres and gasoline retailers a range of small exhaust emissions analyzers for in-use vehicle emissions diagnostics. Investing in the latest technical areas, Horiba is also developing reformer unit emissions analyzers for fuel cell vehicles [24], [25].

Innovation process

The Horiba Group concentrates its global marketing and R&D on innovations that meet the demands of automotive engines of the 21^{st} century, including engines powered by fuel cell batteries and other alternative energies. By offering automated integrated gas analyzer systems as well as individual units, Horiba enhances the efficiency of engine development efforts. The Group also provides PM analyzers for diesel engines, positioning itself as a leading manufacturer in terms of exhaust emission measuring technology.

Technology research

In order to achieve technological innovation, Horiba participates in joint research projects with organizations around the world and publishes over 20 major research papers annually. Horiba furthermore cooperates a lot with universities. Recent development efforts have focused on diesel emission gas analyzers and fuel cell development [24].

Management structures

Due to the global character of the company, there are a lot of departments all over the world. Each department has its own specialty (e.g. gas analyzers in Japan, medical in France). The key activities (R&D and production) are done inside each department, because the knowledge is there. However this means the knowledge is spread out all over the world. In order to combine this knowledge, Horiba organizes a meeting with all managers once or twice a year to exchange experiences.

In- and outsourcing

Because Horiba is not the largest company in the industry, it tries to compensate for this by being unique. Furthermore the production and manufacturing of products is outsourced, while the R&D is done in house. This way keeping the research and development to be the main subject. However, Horiba is always active on expansion and also has efforts to build in China. This is mainly because China has a lot of car manufacturers, which can contribute for instance to the development of exhaust gas analyzers.

Technology push versus market pull

The Horiba Group is using the concept of market pull in trying to find a good emerging market and then try to apply the right products. If there is no competition in a market, this means it is easy to enter the market fast. Horiba likes to be the fastest, but if others already have entered a market, this means it is a good market.

Sustaining versus disruptive technology developments

Sometimes Horiba is able to create a market itself, because Horiba is always looking at new technologies and trying to bring them into commercialization. A nice example of this is the development of high sensitivity gas analyzers. First the analyzers were developed, after which the government was asked to change the environmental law and therefore creating a new market.

Modular and integrated design

Horiba's modular product design allows customers to add new capabilities to their test cells with minimum changes to their existing equipment. Thus, Horiba's R&D capability and product design philosophy assures that test cells equipped with today's quality products can be upgraded with emerging technologies [24].

Environment

Amid long term, increasing global interest in the environmental effects of vehicle exhaust emissions, the EMD division generates consistently stable sales and earnings growth. It has grown to become a core part of Horiba Group operations. The market is characterized by the adoption of increasingly strict regulatory requirements across a rising number of countries. Horiba expects this trend to continue, prompting higher demand for innovative measurement technologies as exhaust emissions are reduced to levels that are difficult to detect and measure. Stricter rules on diesel engine emissions are also generating considerable demand for new diesel measurement systems, notably in Europe [25].

5.4.3 Hitachi PERL

In 1910 Hitachi was founded by Namihei Odaira as an electrical repair shop. In the five years after they began manufacturing small electric appliances like voltmeters and fans. Since then they have produced locomotives, transformers, elevators, refrigerators, power shovels, turbines, electron microscopes, on-line banking systems, cars and traffic control system for the shinkansen. As you can see Hitachi is operating in almost every area that has links with electrical engineering. It also has a large R&D department that is divided into six laboratories: Central Research Lab, Advanced Research Lab, Hitachi Research Lab, Systems Development Lab, Mechanical Eng. Research Lab and Production Eng. Research Lab (PERL). The last one is the lab we have visited during the study tour.

PERL was established in 1971. PERL supports all manufacturing activities through R&D aimed at developing advanced manufacturing techniques, improving product development efficiently, building total supply chain from the procurement of parts materials to the shipment of products, and developing production processes that are environment sound.

Basic data was collected from [26] and [27].

Number of employees: - Hitachi global - Hitachi research - Hitachi Perl	 326,344 5,700 600
Turnover (Hitachi global):	¥8,632,450 million
R&D expenditures:	¥371,849 million
Location:	Kanagawa, in the south of the Tokyo-Yokohama Metropolitan Area.
Process description:	The Production Engineering Research Laboratory Contributes to the Progress of Industry and Society through Development of Futuristic Production Technology.
Main relationship with other organizations:	PERL is one of the six research labs of Hitachi and collaborates with domestic and overseas universities and research institutes.

Table 5.11: Basic data Hitachi

Electrical Engineering

As you have seen in the introduction Hitachi manufactures just about anything that has an electrical current flowing through it. Their products vary from high power turbines and generators to DRAM and embedded systems for mobile phones. PERL, the lab we have visited only covers a part of the R&D that Hitachi does.

The Production Engineering Research Laboratory supports all manufacturing activities through R&D aimed at developing advanced manufacturing techniques, improving product development efficiently, building total supply chain from the procurement of parts materials to the shipment of products, and developing production processes that are environment sound. The research at PERL is divided into 7 fields: Production Systems, Integrated Manufacturing Systems, Inspection Systems, Machining, Process Technology, Packaging and Circuit Design & Packaging. The results of the research are grouped into four categories.

The first category consists of Product information systems. This group covers anything from development process management to product line design and inventory optimization systems. This is done to be able to respond quickly to changing customer demands.

The second category consists of electronic devices. In this category the technology for LSI chips and displays is continuously refined to allow for higher-density storage of mass data and higher-definition, higher-quality display of information. Examples of products in this category are: Patterned wafer inspection technology, LCD mass production technology and Spray cleaning technology for large-sized substrates.

The third category consists of information and information media. In this category Hitachi tries to respond to the growing demand for communication systems which are more compact in size with higher information processing speed.

The last category consists of leading-edge technologies. In this category research is done with a close eye on the future and in this way it can contribute to the progress of society. Examples of products in this category are: superconducting coil forming machine, lead free solder, and a real time 3D profile sensor. For the development of lead free solder Hitachi is in a consortium with a number of other companies. A committee existing of one person of each company manages the research project [27].

Innovation process

In this section the innovation process at Hitachi is discussed using the innovation questions as a guideline. These questions are only a guideline because not all questions have been answered.

Technology research

Since its founding in 1910, Hitachi has acted from a corporate philosophy of contributing to society through technology. Although the world and society have changed, Hitachi has maintained its pioneering spirit. Embarking upon the new century Hitachi is becoming even more dynamic. With the phrase "Inspire the Next", Hitachi is declaring its vow that the Hitachi brand will meet the expectations of our customers and society in this new age. This statement embodies Hitachi's commitment to continue to inspire coming generations with the latest products, systems and services. Innovation at Hitachi is aimed at making it its customers' Best Solutions Partner, as a global supplier capable of offering total solutions.

At PERL these innovations can be observed in two places. The first place is the fourth research category of PERL. As you have seen research in this category is not yet ready for implementation in Hitachi's products, but still in a refining phase. This research is especially done to be able to stay ahead and create new products in the future. This branch of the PERL is continuously innovating and exploring the possibilities of new technology in the future. The other place where innovation can be noticed is in the strategy of Hitachi. Where Hitachi used to supply machinery for production lines, it is now delivering full end solutions. Hitachi is now building total supply chains from the procurement of parts materials to the shipment of products.

Hitachi is a very broad company, with six large research laboratories, so it is hard to tell what the core technology of Hitachi is, actually all seven research fields mentioned under "Electrical Engineering" are researching different core technologies of Hitachi. To prevent these core technologies from leaking away from the company Hitachi does not allow its employees to unfold businesses of their own next to their job at Hitachi. Another way from keeping the intellectual property within the company that is used at Hitachi is to patent new inventions. Sometimes technologies are invented that do not really fit into the current business, but in some cases it is possible to develop this technology at another business. But sadly in other cases the technology is not fitted for Hitachi and the patents end up useless on the shelf. Hitachi hardly ever sets up new venture companies for the further development of technologies.

Management structures

The management of R&D at Hitachi is done by the R&D group that is directly under the president. Each Laboratory has a general manager that is under the direction of the R&D group. The structure of the management is the same in outline for the different labs.

In- and outsourcing

It has not become clear whether Hitachi outsources some of its research, but Hitachi does have some cooperation projects with both universities and other companies. Hitachi is also actively looking for new technologies abroad. A way of obtaining this knowledge is to buy the company that does the research. Since Hitachi is a large company this usually is not a big problem. When foreign businesses are bought by Hitachi, it does not introduce all the moral codes and company culture of Hitachi, because that might hinder the original company in its research.

Sustaining versus disruptive technology developments

Because there are different research labs doing research in different fields, the market also has different influences on the research at Hitachi. The leading edge research has to be done to keep a step ahead of the market and guarantee a good market in the future while the contact with the markets at other fields is much closer. Hitachi has a special 'monozukuri' or prototyping concept that links the customer, the supplier and the market to the manufacturer to improve productivity, reliability and speed of the R&D department. Because of the different labs, the focus is not just on disruptive or sustaining technology, but certain labs put more emphasis on new disruptive technologies while other more focused on sustaining technology. Because of the size of Hitachi, they can take more risks when researching disruptive technologies.

Supply chains

Altogether Hitachi has a great advantage on innovating and that is the size of the company. Because Hitachi is such a big company that it is much easier to free money for research and development and specialize in leading edge technologies. Another advantage of the size is for the innovation towards full supply chains. If you only make one machine it is a huge step to producing supply chains. If you build most machinery required for your supply chain it is a relatively small step to producing the full chain.

5.4.4 Matsushita Electric

Matsushita Electric is also known as Panasonic. Founded in 1918 by Konosuke Matsushita, the company started with the invention of an innovative attachment plug and a two-way socket and expanded in the electronic market. Matsushita soon became analogous with good quality for low prices. In 1952 Matsushita set up a joint venture with Philips as an overseas partner with the goal to adapt advanced western technology. Nowadays Matsushita has subsidiaries in the United States, Europe and Asia, making it one of the top 20 of largest companies in Japan [28].

Matsushita is divided in five distinct segments: AVC Networks, Home Appliances, Components and Devices, JVC and Other, making products including LCD TVs, computer devices, cellular phones, refrigerators, healthcare equipment, lamps, semiconductors, batteries, industrial robots, escalators, bicycles and Karaoke systems.

The current focus of Matsushita is on the rapidly growing economy of China and the emergent market in Russia, while unifying products currently sold in the United States and Europe under the Panasonic brand.

Basic data of Matsushita Electric can be found in table 5.12.

Company name:	Matsushita
Founded:	1918
Number of Employees:	290,493
Location world headquarters:	Osaka
Turnover:	$71,921 million
Research and Development Expenses:	$5,570 million

Table 5.12: Basic data Matsushita Electric

Electrical Engineering

Matsushita consists of five distinct segments, each contributing to and depending on the achievements of Electrical Engineering.

AVC Networks

AVC (Audio, Video and Communication) Networks contributes to the realization of a ubiquitous networking society through advanced technology. The company's strategic growth products, including digital TVs (DTVs) and DVD recorders, as well as SD Memory are a market success. Third generation (3G) cellular phones, IPv6-compatible network cameras, car multimedia systems featuring DVD and hard disk drives (HDD) show promising prospects. This section accounts for almost halve of the activities of Matsushita.

Home Appliances

The products used in the home, such as refrigerators, washing machines and air conditioners make up a large portion of the energy consumption of a household. Matsushita strives to improve the efficiency of these machines and to eliminate the use of pollutants such as HCF. The company also develops healthcare products. Glucose meters using tiny blood samples, ultrasonic diagnostic equipment and three dimensional imaging are the strengths in this field.

Components and Devices

Semiconductor system and LSI design is the focus of this segment. The 90nm production plant drives the production of low-power high speed ultra fine image sensors, System-on-a-chip and FeRAM. These devices will not work without power, so this business section also produces batteries, with the emphasis on rechargeable batteries used in notebooks. Also products such as capacitors, PCBs, HiFi speakers and electric motors with fluid bearing are part of the vast repertoire of Matsushita.

JVC

In 1954 the Victor Company of Japan became part of Matsushita Electric. The goal of JVC is to become an "Entertainment Solutions Company". In line with its brand statement "The Perfect Experience", JVC will provide customers with an enhanced experience in audio and visual quality.

Other

While the other segments mainly focus on consumer related products, Matsushita also has activities in factory automation. In the electronic component mounting business, the company is launching new products, including high-speed modular placement machines that boast the industry's highest level of productivity, and process equipment such as high-speed screen printers that feature colour two-dimensional solder inspection as well as pharmaceutical support robots that automate processes in new drug development.

Innovation process

Because Matsushita consists of a large numbers of companies, each belonging to one of the five segments, it is a challenge to manage innovation. The goal of the innovation policy of Matsushita is to reduce the development time and to increase the return on investment [29]. There is a new style of management to achieve this, because in the current and future market only the fastest company will earn profit on a new technology. A result is that LSI and software are becoming more important and R&D expenses rise. Also offering digital services such as e-shopping is a focal point.

R&D

Research and development itself is done both centrally as well as within each company. In that way the invention process can be more creative and advanced in each company while the management of innovation and advanced science is done centrally by the central laboratories. To prevent double work and to keep standards high, a common platform structure strategy is used to manage the different R&D labs. A common framework exists to share core technologies such as software developed by the various business domain companies and system LSIs, thereby establishing a more efficient R&D process. About 60% of the companies and R&D labs are located outside of Japan.

Internal communication is always difficult in a multinational company. A special IT system is used called Phase Change Management. In this way it is always clear at what stage a certain technology is. At every transition to a new phase there is a discussion between different kind of employees, such as engineers and managers. There are no formal barriers between R&D centres; the communication is dependant on the initiatives of the employees.

Alongside the common platform structure strategy, Matsushita has innovated R&D management through the selection of priority R&D themes at the Corporate R&D Group and in development processes at business domain companies. In addition, the Corporate R&D Group has introduced Phase Change Management (PCM), which breaks into segments, evaluates and manages the various development phases through product launch. Regarding R&D processes at the business domain company level, Matsushita introduced DPIM, a system for the evaluation and management of R&D at each development phase, with a focus on return on investment. DPIM has resulted in dramatic reductions in product development lead times.

R&D decisions, the choice of what should be done, are done in two ways. Sometimes it is bottom-up. Engineers have the freedom to explore what they want, as long as it is interesting. Most of the time it is commanded down centrally. This is when a certain technology strategy is pursuited. At phase 0 the patent is applied which covers basic technology. In principle everything new will be patented and treated as a black box, to promote use in other products. In phase 1 refinements are added. During phase 0 every topic is allowed, as long as it is applicable in a reasonable time. During the phase transition to phase 1 a go/no-go decision is made. If the technology is not suitable for Matsushita, there are different options: a spin-off can be created and supported, the patent could be sold or it can be stored for later use. In principle the R&D results of the local laboratories are small improvements of existing products.

Intellectual property

To enhance Matsushita's competitive advantage from an intellectual properties perspective, the company promoted patent applications on a regional basis for newly developed technologies. As of the end of fiscal 2004, Matsushita held 48,061 fully-registered patents in Japan, and 38,358 patents overseas, for a total of 86,419 patents. Based on Matsushita's 10-year Technology Vision, which sets forth a company-wide strategy for concentration of R&D investments into priority areas, the company will enhance competitiveness through strategic utilization of patents relating to standards for DTV, DVD and other fundamental networking technologies to support a ubiquitous networking society.

Human resource management

Human resource management is changing. Engineers are normally drafted from universities. On the job training has always worked well, but in the recent years the stagnation has caused a loss of interest in engineering among young people. Matsushita plans to recruit engineers in China. PhD students are also attracted, but most of them still have to be trained. This is because the knowledge of Japanese students is concentrated on a very specific subject, instead of divided over all science subjects. During a job interview there is not enough time to measure the scientific knowledge of an applicant. This is a major problem for Matsushita.

Cooperation with others

Cooperation with other companies or universities exists, but is not strong. There is no R&D cooperation with universities, but there is information exchange in the form of the R&D academia collaboration centre which was founded in 2003. Some activities are shared with companies such as Hitachi and Toshiba in the area of LCD panel production, but that is exceptional. National plans do promote cooperation, such as the semiconductor initiative of the government.

Environment

The government is actively promoting energy efficiency and reducing environmental impact, but Matsushita is taking the lead on own initiative. This sometimes proves difficult, because Hitachi owns many environment related patents awarded prior to the government regulations. Also the market demands clean and responsible products.

Matsushita gathers substantial market information from the sales departments, but most market information penetrates the decision makers and engineers automatically. Matsushita is a multinational and it caters to different markets. This results in different demands all over the world. By having R&D centres in many countries the strategy is market oriented by default.

5.4.5 Optoelectronic Industry and Technology Development Association (OITDA)

The Optoelectronic Industry and Technology Development Association (OITDA) was established in July 1980. This association of optoelectronic companies and institutes has the goal to "contribute to the progress of the Japanese national economy by promoting the comprehensive development of the optoelectronics industry and technology and assisting further sophistication of the related industry and additional improvement of the citizens' life".

OITDA aims to reach this goal by four primary activities:

- Technical development;
- Timely standardization;
- Support of new businesses creation;
- International exchange and cooperation.

Fund:	¥700 million
Turnover:	¥2.5 billion
Number directing companies:	13
Number member companies:	172
Number of employees:	41
Location headquarters:	Tokyo

Table 5.13: Basic data OIDTA

OITDA is owned by 13 directing companies. The directing companies we have visited in Japan are: Toshiba, NTT, Hitachi, Mitsubishi and Matsushita.

Electrical Engineering

OITDA has established committees to reach its goals. These committees are, among others (a total of 50 committees):

- Optoelectronics Industry Trend Research Committee;
- Optoelectronics Technology Trend Research Committee;
- Technology Roadmap Committee;
- Standardization Committee;
- New Business Creation Project Committee;
- Near-Field Optical Technology Promotion Committee;
- Kenjiro Sakurai Memorial Prize Committee;

These committees are engaged in the same subjects as the directing and member companies. The companies can be roughly classified by type of business: electrical engineering, chemistry and manufacturing. The electrical engineering companies can be divided up into transducer/material sciences and embedded systems.

The main electrical engineering activities of OITDA are:

- Trend research;
- Making roadmaps;
- Making new standards;
- Starting up new businesses;
- Organizing symposiums, seminars and trade fair.

These are not normal research and engineering activities, but more management-like activities. Most employees work part-time at a member company and part-time at OITDA.

Innovation process

All the activities of OITDA contribute to innovation, because OITDA wants to improve the Japanese optoelectronic industry. These activities of OITDA are:

Study and research. Collect and analyze information of the optoelectronic industry:

- Optoelectronic industry trend research. The production scale of Japan's optoelectronic industry and surveys of the status and trend by field are conducted every fiscal year;

- Optoelectronic technology trend research. The present conditions and trends in the eight optoelectronic technology fields are researched and analyzed each year by studying the literature available both at home and abroad and by sending research teams overseas;
- Drawing a technology roadmap. A technology roadmap is being drawn up to clarify optoelectronic technology needs in the future.

Promoting the Development of Optoelectronic Technology. Support the optoelectronic industry with:

- Optoelectronics R&D projects. OITDA is carrying out R&D projects consigned by NEDO (incorporated administrative agency of the Japanese government) to do fundamental R&D;
- Study and research groups. To promote exchange of the latest information on cutting-edge optoelectronic technology and spur R&D, OITDA has set up six forums;
- Patent Committee. Supporting companies and institutes with patents.

Standardization promotion. Making new standards:

- Optoelectronic industry and technology standardization general committee;
- Standardization technical committee. Propose new JIS (Japanese Industrial Standard) to the general committee.

Creation of new businesses:

- Support and technical guidance for Venture Businesses and Smaller Businesses;
- Feasibility studies on optoelectronic technology projects;
- Optoelectronics system development. OITDA contributes to exploitation of new markets.

International exchange cooperation:

- International meeting of optoelectronics-related organizations.

Public activities:

- InterOpto. This is a yearly international optoelectronic trade fair focused on the international cooperation of the optoelectronic industry;
- Symposium;
- Seminars. Every month a seminar is held;
- Bulletin and homepage.

5.4.6 Thales Nederland

Established in France more than a century ago, Thales is a global electronics company serving Aerospace, Defence, and Information Technology markets worldwide. With operations in more than 30 countries and 65,000 employees, the Thales Group generated 10.6 billion euros in revenues in 2003. Thales Nederland is part of the Thales Group, originating from the Thomson-CSF Group. In 1990 Thomson-CSF incorporated Thales Nederland, at that time known as Hollandse Signaalapparaten. Before 1990 Holland Signaal was part of Philips. The Thomson-CSF group renamed itself in 2000 to Thales Group and, being a member of this group, Thomson-CSF Signaal changed its name to Thales Nederland.

Thales Nederland is specialised in designing and producing integrated systems for command & control, surveillance, weapon control and communication purposes. The company has two branches in defence systems, being Thales Naval and Thales Ground Based. The product range of Thales Naval Nederland comprises systems suitable for all classes and types of naval vessels, any weapon system and any mission. Their long experience with an ongoing search for new techniques and possibilities has resulted in an expertise in the fields of radar, infrared, weapon control, display technology and communications equipment. Modern and highly capable sensor suites, together with the combat management system TACTICOS, equip new generations of frigates, corvettes and fast attack craft throughout the world. Naval capabilities of Thales include sophisticated Anti-Air Warfare systems, featuring APAR, SMART-L and SIRIUS.

Thales Ground Based provides solutions for integrated air defence surveillance, track and fire control purposes, as well as for border and battlefield surveillance.

The headquarters settled in Hengelo has its own Research & Development division in Delft in the areas of radar technology and radar systems. Thales Nederland knows besides three German settlements a few more settlements. One is Thales Communication, settled in Huizen. They are basically active in communication system and networks for military-, naval-, and civil applications. Second, Thales Cryogenics and Thales Munitronics, both settled in Eindhoven. They are working on the development and manufacturing of cooling systems, batteries and (ammunition) fuses. Thales Optronics in The Hague is the last settlement. Optronics combines optics, electronics, sensors, highly sophisticated image processing algorithms and software to provide real-time imaging at any time of day or night in almost any weather conditions. So they develop and manufacture for example IR-cameras.

Innovation process

Technology research

Thales Nederland pursues an active policy of Research and Development (R&D) to ensure that its technologies, products and systems are always on the cutting

Thales Group	
Founded:	1893
Number of Employees:	65000
Location world headquarters:	France
Turnover:	$13,927 million
R&D Expenses:	$2,430 million
Thales Nederland	
Number of Employees:	2600
Location:	Hengelo
R&D Expenses:	$42 million (in 2000)

Table 5.14: Basic data Thales

edge and therefore, R&D activities represent the equivalent of 18% of Group revenues. This provides the Thales Group about 250 inventions per year and a total patent portfolio of some 15,000 patents.

A fifth of the overall R&D effort is directed towards the technologies of the future:

- the main focus is on dual technologies that have significant potential in all three business areas (Aerospace, Defence and IT&S);
- a large proportion of the Group's technological research is aimed at reducing the costs of increasingly complex products and systems through innovative tools and methods for systems engineering, electronics and software projects.

Thales Nederland needs many core technologies for the development of radar systems. Important areas are algorithmics, in which it regards itself as leader, and material science. Both these subjects are researched in-house. Some components for which home development is not very fruitful are bought from other companies, like for instance DA converters. Thales Nederland tries to keep knowledge within the company by means of physical security and an Intellectual Property (IP) division, which takes on cases for the whole group.

Management structures

Thales Nederland in Hengelo works within the global Thales Group on air defence systems, which has a number of subdivisions. Each of these subdivisions has a Technical Director who has 10 different technology areas, for instance receivers, mechanics or packaging, to look over. Each of these technology areas, in the case of air defence systems, has two portfolio managers, one for the Dutch part of this area, and one for the French part.

In- and outsourcing

The Thales Group performs both in- and outsourcing, and decisions to do this are made for each case. It can occur that partners outside the Thales Group are chosen although a division in this area is present within the Group. Motivations for in- or outsourcing can naturally be diverse: knowledge, time, money, politics, etcetera.

Environment

Thales Nederland works closely with the University of Delft and the University of Twente. Furthermore, they have a close cooperation with TNO, an important institute in the Netherlands. Because of the nature of the products, Thales Nederland also works a lot for and with different governments. Information developed in a certain project funded by a government can be restricted to stay within the Thales Group or even within a division of Thales Nederland. For example, a project that is funded by the Dutch government can be assigned as classified for divisions of Thales Group outside the Netherlands. Furthermore, regulations of these governments often demand higher expenditures for technological developments in the concerning areas. On the other hand, most regulations have exceptions, and governments can by-pass them if they think it is necessary, mostly to push the costs of these products down.

Technology push versus market pull

Thales Nederland is a technology push oriented group. It develops products and tries to convince customers to buy these new products.

Sustaining versus disruptive technology developments

Thales Nederland can best be characterized as a very fast follower. It is continually scanning for new ideas or technologies and adopts them if they seem promising. To make a good decision about these new subjects, studies are made early in the process. This also clarifies the future of these subjects fast, which limits the (unnecessary) expenses.

Allocation of resources

Before starting a project, a study is made concerning all aspects of this project. This study is evaluated and a decision is made if this project is worthwhile. After approval, the height of the budget of this project is determined. This budget can contain funds of the concerning business unit or external funds. External funds can be funds outside of Thales Group but also funds from other business units of Thales Group.

Modular and integrated design

The Thales Group is more focused on integrated design, because it develops mostly complete package products. The products are often adapted to the form factor of the concerning application.

Acquisition of knowledge and intellectual property

As mentioned in "Technology research", within the whole Thales group exists one division that handles Intellectual Property. A task of this group is to decide if it is necessary to patent an idea, which is often a cost effective decision, or just try to keep the idea within Thales. This group also handles patents from other companies, which might be needed for Thales products.

5.4.7 Strukton Systems

Strukton Systems is part of Strukton Railinfra, which is part of one of the largest construction companies of the Netherlands: Strukton. Strukton Systems focuses on mobility systems for both rail- and non-rail affiliated applications to work on high-quality projects nationally and internationally. They also deploy expertise in the area of power supply, infrastructure and (traveller) information systems, safety and electrical systems in rolling stock. As a result of close cooperation with the service departments of Strukton Railinfra, they are in a position to offer total solutions, from concept up to and including operationally ready delivery and maintenance service.

Strukton Systems is market leader in the Netherlands in the area of traveller information systems. They provide solutions that are at the root of the technology of tomorrow for the city and rail mobility, energy and (rail) infrastructure markets. The latest developments are focused on systems for automatic payment, automatic ticketing, and access control. The focal points are the mutual exchange of ideas with the customer, innovation, and development. Strukton Systems has 250 employees and offices in the Netherlands in Hengelo and Utrecht, and in Aken, Germany.

Company Name:	Strukton Railinfra
Number of Employees Strukton Railinfra:	2100
Number of Employees Strukton Systems:	250
Locations:	Maarssen, Hengelo, Aken (Germany)
Turnover:	$482 million
R&D Expenses:	unknown

Table 5.15: Basic data Strukton

Innovation process

To describe innovation at Strukton Systems the POSS system is discussed, as it is the prime example of innovation within the company. It will be shown that the company operates in an environment which inhibits innovation, while it is much needed.

POSS

Passengers and the authorities are making increasing demands on the quality of public transport. Delays are no longer being accepted. Guaranteeing rail availability is more important than ever before. In this context, the responsibilities are shifting from the owner of the track to transport companies and process contractors. Fines as a result of delays are to be expected. Track objects, such as points, that are not functioning properly are no longer acceptable. Strukton Railinfra, equipping itself to deal proactively with this trend, has developed the POSS monitoring system that predicts faults before they actually occur. The concept of the system was invented by a company which later became part of Strukton Railinfra. At Strukton Systems POSS was further developed and eventually made operational in 2004.

Environment - market

Railway construction in the Netherlands is very different from railways in Japan. Where in Japan multiple companies exploit multiple lines, in the Netherlands there is only one customer that wants railways to be built: Prorail. The fact that Prorail is the only customer gives it tremendous influence. This used to be a governmental role, but it has been gradually privatized to become independent in 2002. Prorail describes itself as a new organization with decades of experience. This presents clear drawbacks as the bureaucratic conservative governmental culture is still present. Another point is railway safety. The Dutch have one of the safest railway systems in the world and it is heavily regulated. Only systems which are thoroughly tested and used before are applied in railway construction. Strukton Railinfra thus faces an extremely conservative market in which innovations are greeted with suspicion and scepticism and often simply refused. In other words: there is no market pull for innovation.

Environment - mother company

Another environmental factor is the mother company. Strukton Systems is part of Strukton Railinfra, which is part of Strukton. Strukton Systems is a small dynamic part within the conglomerate of Strukton, which has also some conservative properties due to the culture of construction companies in the Netherlands and the fact that Strukton Railinfra used to be part of the governmental national railways. The company cannot be directly compared to the other production companies in this research. A production company invents, designs and creates products to be sold to customers. By improving the products the customer can be persuaded to buy. Strukton Railinfra however is a capacity company, which means it delivers material, labour and services to be used by the customer Prorail to maintain the current infrastructure. There is no real development and sales because there are no clear products. A small and slow change in this attitude is noticeable because the different railway construction companies which used to be the national railways are behaving more and more competitive.

Disruptive technology

The creation of POSS proved to be disruptive for the customer Prorail as well as for Strukton Railinfra itself. Because of its enormous potential it was pushed to the market to convince both the decision makers as well as the customer. When it showed to be useful, the conservative forces started to support and adopt it. The POSS system is now also licensed to competitors and the number of railway failures has been reduced dramatically. Still the focus of Strukton Railinfra is on the delivery of capacity and the POSS activities are welcome, but not essential.

Intellectual property

Most of the new ideas are patented, but some are kept secret. The creation and absorption of ideas are supported, whether coming from inside the company or from outside, but only if they are sustaining existing technology.

R&D

There is no separate R&D centre in the company; research and development are done as a result of normal work activities. This shows that innovation can take place in an environment where it is inhibited. The major supporting factor is the endurance of a small dynamic team that wants to seize the opportunity to improve a conservative technology.

5.4.8 Texas Instruments

Texas Instruments was founded in 1930 by John Clarence "Doc" Karcher and Eugene McDermott as "Geophysical Service", using seismology to find oil. Nowadays, Texas Instruments designs and manufactures high-technology components and systems for more than 30,000 customers worldwide. The company has three separate business segments: Semiconductor, Sensors & Controls, and Educational & Productivity Solutions. Semiconductor is the largest and accounted for 85 percent of the company's revenue in 2003. TI is among the five largest semiconductor companies in the world [35].

Texas Instruments has three sites in the Netherlands. The Sensors & Controls division in Almelo is responsible for controls and sensors for Europe's automotive and appliance industries. The site also houses activity for the Texas Instruments Radio Frequency Identification System (TI-Rfid^{tm}) business. TI also has a semiconductor sales office in Zaltbommel and a European Logistic Centre in Utrecht.

The contents of this subsection apply to the Sensor Business Unit, which is a part of the Sensors & Controls division within Texas Instruments. It therefore does not directly apply to the other business segments within Texas Instruments.

Some basic data about Texas Instruments can be found in table 5.16. The core technologies of the Sensor Business Unit are: pressure sensing, force sensing, and RFID (Radio Frequency Identification). A more detailed breakout of the primary technologies, markets and end-equipment applications of the three business segments is shown in table 5.17 [36].

Company name:	Texas Instruments
Company size:	129 group companies
Founded:	1930
Number of Employees:	35,800 employees globally
Location world headquarters:	Dallas
Turnover:	$ 9,834 million
R&D Expenses:	$ 1,748 million

Table 5.16: Basic data Texas Instruments

Innovation process

Technology research

At Texas Instruments, research and development is integrated in one department. Real fundamental research is not carried out within TI sensors but TI cooperates with technology partners to have access to technologies needed instead of developing new technologies from scratch. For production TI has production sites located in low cost regions and also hires temporary engineering capacity to guarantee a certain degree of flexibility.

Management structures

The global sensor business unit is headed by a global business unit manager (Vice president) and organized in three regional business units; the Americas, Europe and Asia, all lead by a business unit manager. Within each regional business unit there is a marketing manager responsible for marketing and sales and there are one or more (depending on the size of the engineering department) design engineering managers responsible for the technology and product design.

In- and outsourcing

As stated above TI cooperates with other companies to have access to technologies they need. For production TI has its own Best Cost Producer sites within

Business Segments	Product Focus	Key Markets and End Equipments
Semiconductor	Analog and digital signal processor (DSP) integrated circuits for real-time applications	Communications: wireless handsets and infrastructure, broadband, telecom Computing: notebook and desktop PCs, hard-disk drives, printers, monitors Digital Consumer: digital still cameras, digital audio, DVD players/recorders, HDTV Automotive Industrial
Sensors & Controls	Sensors that improve safety, control products that prevent damage from overheating and fire, and radio frequency identification (RFID) systems that provide security and asset tracking	Automotive Heating, Air Conditioning and Refrigeration Home Appliances Industrial
Educational & Productivity Solutions	Educational technology including graphing and scientific handheld calculators; datacollection devices for math, science, language arts and social studies	Educational: administrators, classroom teachers Consumer: middle- and high-school students and their parents

Table 5.17: Business segments Texas Instruments

the Global Business Unit located in different regions (Mexico, Malaysia, China). TI also hires temporary engineering capacity to guarantee a certain degree of flexibility.

Spin-off Enterprises

TI does not have a strategy to set-up spin-off enterprises.

Environment

While in most situations governmental regulations inhibit technical innovation, TI can take advantage of this situation. If for instance the government decides to change the environmental regulations and allow lower exhaust gas levels, TI can take advantage of this situation by developing new exhaust measurement systems.

Technology push versus market pull

The Sensor Business Unit uses the concept of market pull in trying to find a good emerging market and then try to apply the right products. All products are custom made according to a specification of the automotive customers. This means that the global car makers are defining the market for automotive sensors. Market information is mainly gathered by talking to customers which are the car manufacturers. In addition TI attends conferences and workshops to follow and anticipate on general trends.

The marketing department is leading in defining which functionality needs to be developed. The initiation of a development is based on assessment of a business plan made by the marketing department. This business plan contains the costs of the development and the expected revenue from selling this product. The decision whether or not to develop a new product is made in the Leadership team. This team is headed by the business unit manager and the marketing manager and engineering manager(s) are participating.

Sustaining versus disruptive technology developments

The main focus in automotive industry in general is on improving existing technologies, because of the lower risk. However, new technologies will be developed when needed. If for some reason a discovered technology does not fit the business model, it can be sold together with the business. However, in general TI does not develop technologies without having identified a market.

Allocation of Resources

Total engineering capacity is determined by the long range plan in which the expected revenue is forecasted for a period of 3-5 years. This plan contains all development work that needs to be done. It therefore also contains revenue of products that still needs to be developed. The actual development projects are carried out in a real project organization (matrix organization) where the project manager is planning how many resources are needed.

Modular and integrated design

The output of the Sensor Business Unit is sensors which could be considered as integrated products. The strategy is to deliver complete sensors which have a conditioned output that directly can be used in a system. A modular approach could be delivering only the sensing element and somebody else would then do the signal conditioning. Since the added value of TI is the automotive packaging and signal conditioning, the strategy is based on delivering complete sensors.

Acquisition of knowledge and intellectual property

Intellectual property is protected by patents and specific clauses in labor agreements. Even in an integrated product the intellectual property has to be protected since it is always possible, and therefore always happens, to reverse engineer a product and analyze how the individual components are working and how they are integrated into one product. The knowledge within TI is kept up to date by intensive training programs and by continuously growing, creating the need to hire fresh highly educated people.

TI has a policy to reward technical experts by the so-called technical ladder. This means people can promote to higher job grades solely because of their technical contributions. This is a separate path from the managerial ladder.

In the automotive sector a lot of standards are used to which products and even development processes should comply. These are more or less general standards that are used throughout the industry. All products developed at TI need to meet these standards and also the internal development process meets general automotive quality standards.

5.4.9 Océ

125 years ago, pharmacist Van der Grinten was looking for new activities, and found one in the research for butter dyes. This occasion is known as the birth of Océ. After developing all kinds of dyes, inks and the blueprint paper O.C.(from which the name Océ is derived) the company developed printing and copying technologies. Now, Océ is one of the leading suppliers of printing systems and document solutions for larger organizations.

Océ has its headquarters in Venlo, the Netherlands. Also in Venlo the largest part of the R&D department and the production department is housed. Océ has branch offices in 30 countries and about 23.000 employees throughout the world.

For the development of new product Océ uses technologies developed in its own R&D department. This way Océ optimises the exchange of information and also can maintain the high standards for productivity and usability of its products. To be able to maintain its position on the market, Océ has to develop new technologies and experiment with new ideas.

Number of employees Océ global: Océ research:	 22,204 1,928
Turnover: (Océ global)	€2,769.3 million
R&D expenditures:	€208,321
Location:	Venlo, The Netherlands
Process description:	The Océ R&D lab develops and builds prototypes of copiers and printers
Main relationship with other organizations:	Océ R&D is closely related to the other Océ businesses, and located close to the production and management buildings

Table 5.18: Basic data Océ

Electrical Engineering

Printing and copying is more and more becoming the domain of the electrical engineer. Where printing was a pure mechanical process a few decades ago, modern day printers are flooded with electronic circuit boards and electrical sensors and actuators. All these electronics give printers far more possibilities and quality. Speed, energy use, noise production and many other factors can be optimized, and with the decreasing size of electronics new functions can be added to printers every year.

Océ is exploring many of these design spaces, and most of them are in the area of the electrical engineer. Océ produces software for document management, printing on demand, they produce the control of the paper path for printers and real time image processing, so many areas are covered by the R&D of Océ.

Innovation process

At Océ an innovation is more than an invention, an innovation has to be useful in the future, it has to change something. Therefore the form of innovations at Océ is more of the disruptive type. Speed of product development is different for different product lines. The black and white (b/w) printing for example is a very mature technology and the development is mainly focused on cost, certainty and environmental friendly improvements. There are no big steps taken in b/w, only optimizations. Océ invests enough R&D resources to keep its position on the market, but the main trends for the near future are shifting towards full colour applications, high volume production printing and document management. This is where the largest part of the R&D resources is allocated. So innovating is not just improving printers but creating a total solution with both hardware and software for the document management problem.

To innovate, Océ does not only have an R&D department but also an engineering department. The R&D department is one of the critical factors of success for the company. The task of the research department is to generate new ideas in all areas Océ is working in. The task of the development department is to create new machines using these ideas and being able to make the step into the future. Their task can be described as making the right thing. The task of the engineering department is then to make the thing right and satisfy the needs of the customers. The ratio of number of employees on each department Research:Design:Engineering is 1:2:7. To prevent knowledge leaking away from the company, Océ tends to be very defensive and usually does not hesitate to request patents for new technologies. In the field where real new research is done no patents are requested in order not to show what new fields the research is being done in.

Océ is a typically Dutch company, and that has both advantages and disadvantages. The best ideas emerge when discussing a problem, but one of the weaker points of the Dutch way according to Océ is making decisions. Another factor that inhibits innovation is the government, but not just the Dutch government. The Dutch government has regulations on safety, noise production and energy consumption of the machines produced. But Océ sells its products all over the world, and the government of the US for example has very strict regulations for carcinogenic substances.

To investigate the wishes of their customers until 2001 Océ did strategic planning with a number of their lead customers. But the Dutch culture prevented this from working well, the group was too small and the area too wide, so now customers are more directly involved with the research. Customers have the most influence on the front-end of the products of Océ. By adapting software a fuzzy front-end can be created easily and cheaper.

To keep the designs of their products simpler the interior of printers and copiers is modular, this makes machines easier to service and it is also possible to use parts from other companies. To be able to use modules of other companies the interfaces between modules have to be standardized, so standards are very important for Océ. Together with IBM, Xerox and a number of other companies Océ is in a consortium to create a new standard: the UP3I (Universal Printer Pre- and Post-processing Interface). This standard is an open, expandable and intelligent interface standard for all the hardware components in the digital print process. For the users modularity of products is not useful so Océ delivers full solutions. UP3I will centralise and unify process control for all the equipment on the print line, laying the foundation for CCM (Computer Controlled Manufacturing) in digital printing.

5.4.10 Discussion

The companies have been described, so it is possible to compare them. Although only one division or department of a certain company has been visited, the complete company will be taken into comparison. The Japanese companies are all founded in Japan, but only two of the Dutch companies are founded in the Netherlands. The turnover, total R&D expenses and total number of employees are listed in table 5.19.

	Total turnover	Total R&D	Total employees
Japanese companies			
Toshiba	$52,637 million	$3,176 million	161,286
Horiba Ltd.	$652 million	$34 million	3,808
Hitachi	$81,438 million	$81,438 million	326,344
Matsushita Electric	$71,921 million	$5,570 million	290,493
Dutch companies			
Thales	$13,927 million	$2,430 million	65,000
Strukton Railinfra	$482 million		2100
Océ	$4,851 million	$273 million	22,204
Texas Instruments	$9,834 million	$1,748 million	35,800

Table 5.19: Overview CIUs division 33

Toshiba, Hitachi and Matsushita Electric are much larger then the Dutch companies, so the total R&D expenditures are higher. On the other hand Thales and Texas Instruments spend more then 10% of the turnover on R&D and the Japanese companies spend between 4 and 8% of the turnover on R&D.

Strategy on innovation

One big difference between Japanese and Dutch companies appears to be a broad or narrow competitive scope. Toshiba, Hitachi and Matsushita Electric have a broad scope, they are active on many different markets. Thales, Strukton Systems, Océ have a narrow scope, they are active in one or few markets. This means the Dutch companies have only specific knowledge of technology necessary for their markets. The Japanese companies have knowledge of wide range of technologies. Horiba Ltd. is specialized in measurement technology and uses this technology for products on different markets.

The differences in broad and narrow competitive scopes are:

- The narrow competitive scoped companies have narrow result fields. This makes the chance to create products for a new market much smaller or zero;
- The broad competitive scoped companies have usually more problems with the efficiency of R&D. It takes more effort to communicate and to collect the knowledge. The chance of doing the same thing twice is a lot larger.

All companies try to be competitive with uniqueness. This results from the strategy to be innovative and to have the newest technology. The way the companies try to reach this goal differs. Matsushita Electric tries to be innovative by reducing the development time. Hitachi tries to be innovative by using innovation questions. The other companies try to be innovative with collecting and creating knowledge and technology for new products. In Japan this is supported by the OITDA.

The strategies on innovation of the companies are shown in table 5.20. Horiba and Strukton Railinfra are not mentioned, because Horiba has a broad and a narrow competitive scope and Strukton Railinfra is active on a very small market.

Competitive scope	Low cost	Uniqueness
Broad	Low-cost leadership	Differentiation Toshiba, Hitachi, Matsushita Electric
Narrow	Focused low-cost leadership	Focused differentiation Thales, Océ, Texas Instruments

Competitive advantage

Table 5.20: Porter's competitive stategies [38]

Innovation process

The big Japanese companies have different innovation processes. The big companies have split up the R&D in sustaining and disruptive technology development. The disruptive technology development is done in big R&D centres. The research in these centres is more fundamental and long term. The research at R&D departments at the divisions is applied and short term.

The Dutch companies have one or more R&D departments, but these departments do the research in one field. This means that at the R&D departments both sustaining and disruptive research will be done. The Dutch companies are more very fast followers than market leaders, so R&D is more focused on gathering new technologies and using it for new products than doing basic research.

The choices companies make regarding technology push versus market pull, sustaining versus disruptive technology developments and modular versus integrated design depends more on the market and customers, than the companies are free to choose. The customers have to buy the product. For example Strukton Systems has very conservative customers, so Strukton Systems is very careful with introducing a disruptive technology.

General expectations versus our experiences

In the past (1960-1985) Japan had the name to copy/improve products from competitors and produce them cheaper in companies with a strong hierarchy (top down communication). This is not how the Japanese companies are now. There is little or no difference in organization structures in comparison with the Dutch companies.

The biggest difference we can find are the people. Japanese people are more polite, and not as outspoken as the Dutch people. Dutch people voice their opinion more often then Japanese people, especially on hierarchic places as e.g. the work floor. This is a cultural issue. Toshiba puts effort in getting its employees more assertive. Toshiba says: "Turning knowledge and inventions into forms that serve the needs and aspirations of individuals and society is what innovation is all about", so the employees have to turn knowledge and inventions into innovations.

Another difference is the influence of the governments. The Japanese government is more active in stimulating the optoelectronic industry. The Japanese government has setup OITDA in collaboration with the optoelectronic industry. In the Netherlands there is no association for this division. This corresponds with the conclusion of the meso research results for the division.

One difference between the conclusion of meso research and our experiences is that Horiba has an advantage thanks to the regulations in different countries, because the demand of measurement equipment depends partly on those regulations.

5.4.11 Conclusion

In the context characteristics and discussion it is mentioned that Japan has larger companies in the optoelectronic industry. These big companies, Toshiba, Hitachi and Matsushita Electric, have the resources to become or stay a technology leader. This means these companies put effort in basic research, which has a long payback time.

The Dutch companies, Thales, Océ and Texas Instruments, are relatively smaller, so they only have resources for small basic research. These companies are very fast followers instead of technology leader. Thales and Texas Instruments try to compensate with relatively higher R&D expenses.

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5.5 Philips and Sony

by Frank van der Aa, Michel Franken and Rogier Veenhuis

In this section, two companies are regarded. These two are Royal Philips Electronics and Sony Corporation. Philips will be discussed first, followed by Sony. This section is ended with a discussion and conclusions.

5.5.1 Royal Philips Electronics

The foundations for what was to become one of the world's biggest electronics companies were laid in Eindhoven, the Netherlands, in 1891. The company initially concentrated on making carbon-filament lamps and by the turn of the century it was one of the largest producers in Europe.

It was in the early twenties that Philips began to protect its innovations with patents, for areas taking in X-ray radiation and radio reception. This marked the beginning of the diversification of its product range. Having introduced a medical X-ray tube in 1918, Philips then became involved in the first experiments in television in 1925. It began producing radios in 1927 and had sold one million by 1932.

Philips' first electric shaver was launched in 1939, at which time the company employed 45,000 people worldwide and had sales of 152 million guilders.

In the 1940s and 1950s Philips Research laid down the basis for later groundbreaking work on transistors and integrated circuits. In the 1960s, this resulted in important discoveries such as CCDs (charge-coupled devices) and LOCOS (local oxidation of silicon). Philips also made major contributions in the development of the recording, transmission and reproduction of television pictures, its research work leading to the development of the Plumbicon TV camera tube. It introduced the Compact Audio Cassette in 1963 and produced its first integrated circuits in 1965.The flow of exciting new products and ideas continued throughout the 1970s: it contributed to the new fluorescent energy-saving lamps, the LaserVision optical disc, the Compact Disc and optical telecommunication systems. The 1990s was a decade of significant change for Philips. The company carried out a major restructuring program to return it to a healthy footing. And more recently it has been concentrating on its core activities [88].

Innovation process

Technology research

Philips has a Research Vision. This vision is as follows:

A world in which innovations in electronics continuously improve people's lives and ultimately merge into environments with ambient intelligence.

Company name:	Royal Philips Electronics
Number of employees: (consolidated):	165,312 (first quarter 2004) 165,615 (second quarter 2004)
Consolidated sales and operating revenues:	EUR 29,037 Million
Founded:	1891
Headquarter:	Royal Philips Electronics N.V. Amstelplein 2 P.O. Box 77900 1070 MX Amsterdam The Netherlands
Representatives:	Gerard Kleisterlee, Philips'president and CEO
Major products:	Medical systems, Consumer electronics, Domestic appliances and personal care, Lighting, Semiconductors

Table 5.21: Basic data Philips [81], [84], [95]

With laboratories in five different countries (the Netherlands, England, Germany, China and the United States) and staffed by around 2,100 people Philips Research is one of the major private research organizations. Philips is Europe's number 1 in patents and it is in US patents top 20. It has over 100,000 patent rights and only in 2003 there were over 3000 patent filings.

Management structures

According to Philips, innovation is about the following items:

- Understanding technology;
- Developing and communicating a vision;
- Understanding business dynamics;
- Positioning in the value chain (i.e. strategy);
- Finding the right partners in the network.

So innovation is a process of selecting from many options in combination with managing risk (versus reward). It is a continuous learning process without guarantees of success.

The mission statement of Philips Research is formulated as follows [90]:

Create value and growth for Royal Philips Electronics through technology-based innovations, improving its global competitive position in its current portfolio, and/or leading the company into developing new businesses.

Philips Research continuously strives for this mission by [93]:

- Exploring the unknown to create new technologies;
- Promoting and demonstrating innovative concepts based on multi-disciplinary strength;
- Building and sustaining a strong intellectual property position;
- Developing our key-capabilities and technologies for future markets;
- Leveraging our capabilities and international presence to influence regional standards and markets;
- Translating global trends in innovation into directions to help shape the strategy of Philips and its product divisions;
- Creating and maintaining an exciting environment to attract international top-talent;
- Being a source of highly skilled people for Philips.

Allocation of resources

The total research budget of Philips Research is 10.2% of the annual sales made by Philips Electronics. In 2003 this research budget amounted to more than €3.3 billion [83]. Roughly two-thirds of the corporate research work is geared to the activities of the product divisions of Philips Electronics, with contractual agreements about programs and costs. The remainder is research of a more exploratory nature.

In- and outsourcing

Open Innovation, a new name for a proven model of inter-company cooperation involves two aspects, both involving changes in the way knowledge moves from one company to another.The first aspect is export. Whereas it used to be relatively difficult to share information, the internet has made it quick and easy. Employees, meanwhile, have become more mobile, migrating from company to company rather than staying with one firm for life. There is a fading boundary between the company and its surroundings. With new venture partners new markets can be entered.

The flipside of this change is that it's now easier to import knowledge from outside. This does away with the need to pour money and resources into developing your own version of something that already exists elsewhere. The key here is for innovators to keep searching not only inside but also outside the company for the next revolutionary idea. Besides an increased number and mobility of knowledge workers there is also an increased availability private venture capital.

In 1970 there was only Philips Research and Philips Businesses which has its own internal supply. Today, with open innovation, Philips Businesses has not only his Research institute but also a network of other business elements. These elements are institutes and other companies, spin-in of technology, technology spin-out, external suppliers and joint ventures of Philips.

Another innovation theme is cross-border innovation. Philips believes those rules don't only apply to companies - they apply to countries too, which is why it is a strong advocate of the so-called "Innovation Triangle". Stretching across the Dutch, Belgian and German borders, the Innovation Triangle of Eindhoven, Leuven and Aachen exemplifies the international scope Open Innovation has taken.

These three technological hotspots contain global centres of research excellence for microelectronics, the automotive industry, healthcare and embedded systems, such clusters can help Europe to create a new generation of industrial champions, for example in Microsystems. The Interuniversity MicroElectronics Centre (IMEC) in Leuven is a prime example of Open Innovation. They established a silicon semiconductor research centre for use not only during the R&D and idea development phase, i.e. in the pre-competitive time frame, but also in an extremely dynamic business and technology area. The current mode of operation is so complex and expensive that all of the leading semiconductor companies are looking for contracts with IMEC to do at least part of their early research there [92].

Environment

Since 1999 Philips started to build a High Tech Campus in Eindhoven. It is Philips' main European open R&D centre on 1 km^2. The main characteristics are:

- 30% Research & Development of Philips;
- Efficient and attractive environment for 8,000 international talents;
- Optimal synergy and efficiency;
- Optimal physical and virtual access;
- State-of-the-art ICT; 3,000 km glass fibre;
- 350,000 m^2 new and renovated buildings;
- Realisation: 1999 - 2009;
- 25% - 50% less energy;
- 100,000 trees.

Philips believes it is important that scientists from a wide range of disciplines, from electrical engineering and physics to chemistry, mathematics, mechanics, information technology and software, work together. By working together they influence and broaden each other's views. This implies that Philips Research reaps the benefits of synergy and cross-fertilization of ideas. Philips works with the system of bottom-up communication. When there are new ideas of employees they can tell these to the management. The management always stimulates the employees to think about new concepts or new products, and the employees are getting the chance to work on their own ideas.

Networking for innovation is also very important. There are different kinds of networking like networking in the region, in industry (cross-fertilization of technologies), with customers, with universities, within the company and last but not least within society.

There are many university partnerships of Philips Research. These partnerships are split up in strategic, strong and specific. Philips has 20 strategic, 200 strong and 2000 specific partnerships. Strategic means there is a partnership between institutes i.e. with TU/e, TUD-DIMES, DPI, IMEC Leuven. Strategic partnerships with Institutes like TU/e contains the participation of many students in Philips' research projects. Strong partnerships are relations from institute to person like TUD, UT, CWI and Philips specific partnership (person to person) with individual contacts.

Technology push versus market pull

Many of the innovations of Philips are driven by technology. If there is an increasing level of technology, it is possible for Philips to innovate with this technological progress. Philips wants to go from a linear to a networked innovation and marketing, and go towards one Philips, the network company. Networking will be used to innovate. Different forms of networking are for example, networking in the region and in industry (cross-fertilization of technology). Other forms are networking with customers, universities, within the company and within society.

It wants to have market leadership where people are the key. Market leadership is driven by various factors. Technology leadership (be early and have leading edge technology), product leadership (create the right products efficiently and on time) and market access (have access to leading customers and markets). People, culture and governance are key enablers for success.

This should be a result of the creation of value. The value creation with innovation is realized by R&D. This is possible by capitalising on past investments and creating future business. Capitalising on past events like selling know-how to third parties, spinning out new businesses and transfer of skilled people. It is also possible by creating future businesses, i.e. transfer to an existing line of business, creating a new line of business and brand image and customer support.

Acquisition of knowledge and intellectual property

As mentioned earlier, Philips is Europe number 1 in patents and it has 100,000 patents in total. The way of creating value with technology starts at developing a new technology. This process will be fully aligned with business objectives. The new technology will be patented so it creates an intellectual property right. The duration from the beginning of creating a new technology to value extraction will be eight till twelve years. Value extraction is possible by sales and trade for sales. It is also possible by cross licensing, exclusivity and direct licensing.

Context characteristics

Philips is very active in Europe. Its recruitment for divisions in its home country is less difficult then the recruitment of companies in Japan. The communication between domestic and foreign employees is more difficult in Japan then in the Netherlands (Philips' employees). The reason for this is in the fact that almost every Dutch inhabitant has learned English in his youth. Most inhabitants in Europe can speak his country language and also English. With this very low language barrier it's easy for Philips to attract company employees from the other countries of Europe. The low language barrier will provide also a better way to gain knowledge in the Netherlands. There are more foreign investors in the Netherlands than in Japan, so Philips can take advantages of this. The Netherlands are easier to access and settle down for foreign companies. There is also a better knowledge transfer between national institutions because of the possibilities to switch between companies as a company employee.

The Dutch innovation climate with respect to the education of company employees has advantages compared to the Japanese innovation climate. In the Netherlands higher education is more involved in the innovation process than in Japan. Highly educated people in the Netherlands are aware of innovation themes and innovation possibilities and when new employees start working at Philips, it's not necessary to teach them about the innovation themes. Japanese companies and private institutions educate their employees themselves, while public institutions only try to make the crossover to labour market as easy as possible.

5.5.2 Sony Corporation

Sony was founded in Tokyo in 1946. It was the brain-child from two people. Masaru Ibuka, an engineer, and Akio Morita, a physicist, invested the equivalent of ¥190,000 to start a company with 20 employees for repairing electrical equipment and producing own products. The name of the company was Tokyo Telecommunications Engineering Corporation. The success story began in 1954, when Tokyo Tsushin Kogyo K.K., of Tokyo Telecommunications Engineering Corporation, obtained a license for making transistors. The transistor was invented in the US, but was not applied in radios. Sony had introduced the first transistor in May 1954 and the first radio completely built with transistors in the next year. Since then there are few companies that equal Sony's list of inventions and renewals. Some important developments are the first Trinitron colour television in 1968, the Walkman in 1979, the first CD-player in 1982 and so on.

Sony is an international company, which has grown from 20 to more than 160,000 employees worldwide. From the beginning, Akio Morita considered the whole world as a consuming market for their company and not exclusively the consumer market in Japan. He understood that the name Sony had to be present expressly on all products of the company. Sony Corporation of America was founded in 1960 and Sony United Kingdom Limited in 1968 [98].

The company name "Sony" was created by combining two words. One is the Latin word 'sonus', which is the basis of such words as 'sound' and 'sonic'. The other word is 'sonny', which means little son. The words were used to show that Sony was a very small group of young people who have the energy and passion toward unlimited creation [85].

Some basic data about Sony can be found in the table 5.22. [85]

Number of employees:	168,000 persons (March 31, 2003) 162,000 persons (March 31, 2004)
Sales and operating revenue:	¥7,496,400 in 2003 for 1,068 consolidated companies and 56 production entities
Locations in Japan:	Tokyo, Kanagawa, Miyagi
Major Products:	Audio, Video, Televisions, Information and communications, Semiconductors, Electronic components

Table 5.22: Basic data Sony Corporation

Electrical Engineering

As was mentioned earlier, Sony has been an important company in the development of consumer goods and electronic entertainment. The excursion to Sony took place in Sony Media World in Tokyo. Sony Media World is used to show and demonstrate the latest technological achievements by the various product divisions.

Grating Light Valve Laser Projector

The first presentation was about the Grating Light Valve (GLV). This is a new technology used to construct laser projectors. The demonstrated GLV device consists of a vertical array of 1080 pixels and is High Definition (HD) compatible. Each pixel is composed out of 6 micro ribbons; each micro ribbon is a Micro Electrical Mechanical System (MEMS). The image signals are used to control the grating ribbon's displacement to result in controlled diffracted light intensity. This provides precise and accurate pixel-by-pixel brightness control. By using a high colour purity RGB laser as the light source, the colour reproduction that can be obtained is twice the colour reproduction area of CRT technology [87].

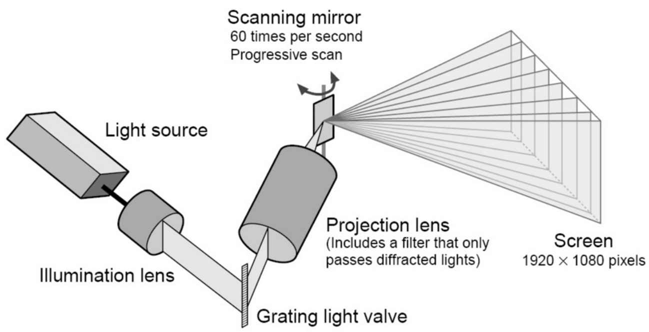

Figure 5.2: Principle of Grating Light Valve laser projector

High Definition Products

The next demonstration was about the new line of HD products that Sony will release. Several cameras are used to demonstrate the enormous contrast and image quality even when the zoom function is used (up to 140x zoom). Besides cameras Sony is also releasing a new line of storage medium designed for HD media is released. These microtapes can store a movie of up to 1 hour of HD quality.

Consumer Products

Next various consumer products were demonstrated. These included among others the latest VAIO PC-model, consumer digital cameras and cellular phones. These are all existing technologies, but Sony has added new features. The cellular phones include for instance a chip that will be used soon to pay for train fares and other expenses (E-money). The latest VAIO can operate for 4 hours without recharging, but it only weighs 800 gram.

Besides these existing products, Sony also demonstrated new products. For instance the combination of a Playstation with a mobile touch screen, which communicate wireless over 30 meters. This can be used to access the internet, read emails, view media (pictures/movies) and play games. Another new product that was shown is the E-book. This is the first digital book that has the same favourable reading characteristics as paper. Because it is a static medium, 10,000 pages can be read without recharging. A new Electronic toy (E-toy) is also shown. The principle is that various objects, representing certain functionalities, in the surrounding are equipped with beacons that can be identified and selected with a CMOS sensor. This sensor is located in a human manipulated object, like a pen/microphone. This allows the user to select the functionality of the manipulated object and use this object to manipulate its surrounding on a monitor. This is demonstrated with functions like drawing fishes, feeding those fishes and adding a diver in the picture.

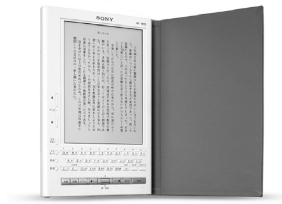

Figure 5.3: Sony's E-book Librië

Qrio

The final part of the excursion was a demonstration of Qrio. Qrio is the latest achievement of the Digital Creatures Laboratory of Sony. It is based on the technology and knowledge gained from the development of AIBO, Sony's electronic dog. Qrio is a humanoid robot with dimension 580x190x270mm (height x depth x width).

In the demonstration two Qrios were dancing. The smooth movements of Qrio are

Figure 5.4: Sony's humanoid robot Qrio

realized by a control system that controls a total of 28 joints. This control system was developed within Sony. This control system is very advanced and empowers Qrio to stand up straight on its own when it is lying on its back. Specialized subsections of the control system are also able to perform complex movements like running, dealing with varying walking conditions, the transition from smooth to rough terrain, and undertaking actions to prevent itself from toppling over. When it does topple over the control system undertakes action to prevent damage to its most sensitive part, its head, and minimize the impact by trying to land on its arms. This is what makes Qrio truly different from other bipedal robots, currently roaming around in various laboratory settings. Running and jumping are very unstable processes and Qrio is the first autonomous humanoid robot that is capable of these activities along with normal locomotion [97]. The two Qrio's used in the demonstration were however unable to run and could not undertake actions to prevent itself from toppling over. This was probably due to the fact that the complete control system could not be loaded entirely in the memory of Qrio.

Qrio has three embedded micro controllers. Each micro controller is dedicated to a single purpose. These purposes are: Moving, sound recognition and communication/image processing. Three micro controllers are used, because one is not sufficient for all the necessary calculations.

Using two CCD-cameras, Qrio is able to detect the distance between itself and obstacles and also the shape of those obstacles by processing the parallax of the images taken by the two cameras [86]. The path-finding routine in Qrio's control software can subsequently plot a course around or to the obstacle.

What makes Qrio a truly interactive robot is its ability to communicate with its surrounding? Using the two CCD-cameras, Qrio can recognize the facial pictures of individual persons. It can also detect the direction of sounds using seven microphones located in its head. Various kinds of data, for example the location of an object and the voice and face characteristics of a specific person, can be stored for later use in both a long-term and a short-term memory. This data can be used for more complicated communication or movement. During the demonstration Qrio produced a speaking and singing voice with vibratos adding a new dimension to interactive robots. The composition of emotional, dynamic speaking and singing through voice synthesis can be realized to improve the robot's entertainment quality [86]. During other demonstrations the engineers of Qrio found that its AI is so strong, that if you haven't been friendly with it beforehand, for example, by not kicking back a football it kicks to you, it will refuse to do what you ask it in the demonstration, effectively expressing its annoyance [91].

All the demonstrations showed how Sony is able to create radical innovative products by combining existing technology with new technology and insights.

Innovation process

In Japan Sony's Mediaworld was visited. During this visit questions were asked concerning the innovation process within Sony. The people that were present at the presentation were engineers on the Qrio project. So some of the information below was obtained of various online sources and the other part was obtained during the presentation at Sony's Mediaworld, but is only representative for the Qrio project.

Management

Sony believes research and development activities are vital to the growth of its business. Accordingly, Sony actively undertakes research and development activities in various areas. Sony's long-term vision on their own research and long-term goals is described by [100]:

Establishment of an ideal factory - free, dynamic and pleasant where technical personnel of sincere motivation can exercise their technological skills to the highest levels... making rapidly into commercial products the superior research results... which are worth applying to daily lives of the public.

This phrase led to the development of the "Sony Spirit", which was described by one of its executive officers as:

Most companies make profit the first priority. Sony's primary mission is to produce something new, unique and innovative for the enhancement of people's lives.

The developers in the Qrio project are stimulated to bring forth new ideas and applications for Qrio, but are not allocated a specific amount of work time to work on these new concepts. After a proposal has been approved by the project management, this concept is integrated in the development process.

Management structures

Sony is divided into several business units that are responsible for matters that require rapid introduction to the market. The technology centres handle matters that require lateral coordination. The overall strategic matters are governed by Sony headquarters itself. The global research centres of Sony are the following nine:

- Contents & Applications Laboratory;
- Broadband Applications Laboratories;
- Networked CE Development Laboratories;
- Ubiquitous Technology Laboratories;
- Storage Technology Laboratories;
- Display Technology Laboratories;
- Materials Laboratory;
- A3 Research Centre;
- Digital Creatures Laboratory.

In addition to these leading-edge fields, Sony is involved in the development at the following three research centres:

- Fusion Domain Laboratory;
- Cyber Technology Laboratory;
- Materials Science Laboratories.

Because Sony is divided into separate units, Sony organizes an annual 3-day exposition that is accessible only to investors and employees. At this exposition, all the researchers of Sony’s different business units get a chance to show and promote their research projects in the hope of attracting new investors and possibilities. This exposition also serves as a mean to show all the employees what kind of activities and projects are going on in other parts of the company.

Allocation of resources

Research and development expenses [80] for the fiscal year ended March 31, 2002 increased ¥16.5 billion, or 4.0 percent, compared with the previous year to ¥433.2 billion. However, the ratio of research and development expenses to sales (excluding the Financial Services segment) was 6.1 percent, which approximated that of the previous year. Expenses in the Electronics segment were ¥383.4 billion, and expenses in the game segment amounted to ¥48.2 billion. Of the expenses in the electronics segment, approximately 64 percent were for development of prototypes of new products. The remainder of approximately 36 percent was for the development of mid-to-long term new technologies in such areas as semiconductors, communications and displays. In the game segment, R&D expenditures centred on next-generation semiconductor architecture and network-related technologies.

Environment

Sony is an internationally orientated company. It has Research laboratories and sales offices in many different countries. This international orientation has always been part of the company philosophy of Sony.

Acquisition of knowledge and intellectual property

Sony is always looking for new technology development in high-tech companies that it can use to create new technological products, or improve their current products. An example of this process is the development of the GLV laser projector [99]. A license was obtained and a new product was developed with that licensed technology.

Sony protects its intellectual property with patents. For example, in 2003 Sony got 1,311 US patents registered [101].

Sony wants to strengthen its bond with universities and other institutes that do research that Sony considers useful for extending their activities [94]. Within the Qrio project however no cooperation takes place between Sony and universities, or institutes.

Technology push versus market pull

Qrio is an example of technology push. The goal of this project was to develop a humanoid robot that could act as an ambassador for Sony. Qrio was meant to show to the world what kind of advanced technology Sony possessed and what they could do with that technology. Several of the 100 Qrio's in existence [Plyojump, 2004] are travelling around the globe demonstrating the abilities of modern robotics.

Sustaining versus disruptive technology

The project team started work on developing Qrio in 1997 and several developers came from the AIBO project. The technology gained in that project was the basis for Qrio. Therefore the development of Qrio is an example of sustaining technology.

Sony uses Qrio as a platform to test new technological advances. Those new advances may result in disruptive technological products.

Modular and integrated design

As was mentioned one of the purposes Qrio is used for is to act as a platform for testing new technologies development in Sony. Therefore its design had to be modular.

In- and outsourcing

Qrio is development by a single development team. Only very specific parts of the project are outsourced and even those parts are only outsourced to other project teams within Sony.

Sony as a whole however does cooperate with other companies on various aspects. The CD was developed together with Philips and recently Sony started a joint venture with Samsung for the production of LCD displays [79]. These are examples of shared research and production activities and therefore in- and outsourcing.

Context characteristics

When Sony was founded, it immediately focused on the whole world as its market. Sony is therefore a contradiction to closed society image of Japan. In the preliminary research it was found that Japan has been very dependent on the US. This former dependency on the US is reflected in the fact that the first international establishment of Sony abroad was founded in the US.

What also contradicts the closed society image of Japan is the content of our visit to Sony's Mediaworld. An extensive tour was organized, a special demonstration of Qrio and even a meeting with two engineers of the Qrio development team. Throughout this program a lot of information was enthusiastically passed on to us. Sony proved to be a more open company than was suspected on basis of the preliminary report.

Japanese people embrace new technology sooner and more readily than Dutch people. Sony profits from this with its home base in Japan, because they can put new products and technology in the media and entertainment sector on the market in Japan very easy. When those products turn out to be successful, an introduction to other markets follows.

5.5.3 Discussion

In this part, a comparison will be made between Sony and Philips on the important factors that shape the innovation policy of the companies.

Technology research

Sony and Philips are both developing electronic products. Sony is focusing almost completely on media- and entertainment electronics, where Philips is focusing on a broader range of electronics. Philips is currently shifting the focus of its activities more toward medical equipment. This means that Philips and Sony will be less competing with each other on these markets in the future.

The research activities of Philips span both product development and basic research. Sony is focusing more on the product development. Sony acquires technology and specific components from other companies that can be used for and in new products.

Management structures

Both Sony and Philips have divided their organization in separate business units. Within these business units, researchers work in teams on their project. Project managers sometimes have several projects to supervise.

Several business units of Philips are located on the High-Tech campus to improve the flow of information between the different project teams and business units. Sony organizes a 3-day annual exposition to improve the flow of information and knowledge between the various project teams.

In- and outsourcing

Philips and Sony both cooperate with other companies in the development of some of their products. Philips worked together with Sara Lee on the Senseo project. And Sony for instance produces LCD displays together with Samsung for use in their mobile telephones and other media. However no cooperation exists between Sony and other companies on the Qrio project.

Environment

Sony and Philips are both international companies. Both companies have offices in many different countries. Philips main research centre in Europe is located in Eindhoven. Other companies are also able to establish themselves on this High-Tech Campus. The purpose of this for Philips is to create a breeding-ground for innovative activities.

Technology push versis market pull

Research and product development in both Sony and Philips are a mix of technology push and market pull. An example of technology push by Philips is the concept of the Senseo apparatus and an example for Sony is the development of Qrio. The development of the CD is for both companies an example of market pull.

Acquisition of knowledge and intellectual property

Sony and Philips are both actively protecting their technology and products with patents. In 2003 Sony got 1,311 US patents registered and Philips got 1,353 US patents registered [Top, 2004]. Philips is more involved than Sony with licensing this protected technology to other companies. Sony keeps the acquired knowledge more within the company to develop products with that technology that are unique.

Allocation of resources

The amount of money spends on research activities by Sony and Philips is almost the same for both companies. In 2002 Sony invested ¥433.2 billion (€3.47 billion) into their R&D departments and Philips invested approximately €3.3 billion in their R&D departments in 2003. Sony invests approximately 6.1% of their annual sales on R&D against 10.2% for Philips.

5.5.4 Conclusion

Philips and Sony are both one of the major electronics companies in the world. Philips is adjusting its innovation policy to new insights. Open innovation is the key aspect in the new policy. This means that Philips wants to make more efficient use of its technology, by letting the world know what kind of advances are made. In its new policy Philips also wants to promote more bottom-up communication, researchers bringing their own ideas forward. Many Japanese companies that we have visited are also focusing on the promotion of bottom-up communication, but during our visit to Sony it was not apparent that they are focusing on this.

Because Sony and Philips are both major companies with literally thousands of employees, it was to be expected that similarities exist in their organizational structure. Both companies are divided into business units where teams of researchers are working on their projects. This seems to be the most applied organizational structure for large companies.

Sony and Philips were both very open during our visits and gave a lot of insight in the operation of their organization and/or projects. Philips is applying more bottom-up communication, where as Sony is applying the more traditional Japanese top-down communication.

5.6 Division 73: Research and Development

by Jos Ansink, Lodewijk Bouwman, Paul Omta, Casper Smit, Kasper van Zon

The institutes regarded in the research belong to division 73. The institutes discussed in this section are:

- SPring-8;
- Akita Insitute of Advanced Technology (AIT);
- Earth Simulator Centre (ESC);
- Research Institute of Electrical Communication (RIEC);
- Institute of Industrial Science (IIS);
- Netherlands Organisation for Applied Scientific Research (TNO);
- MESA$^+$ institute for nanotechnology.

5.6.1 SPring-8

SPring-8, which is the world's largest third-generation synchrotron radiation facility, provides the most powerful synchrotron radiation currently available. SPring-8's ultra-brilliant synchrotron radiation gives researchers exciting opportunities for advanced research in materials science, spectroscopic analysis, earth science, life science, environmental science, industrial applications and so forth.

The Japan Synchrotron Radiation Research Institute (JASRI) is responsible for the management, operation and development of the facility [40].

In compliance with the enacted law, JASRI has started undertaking the following missions entrusted by JAERI and RIKEN [41];

- Management, maintenance, operation and upgrading of the SPring-8 facility;
- User support such as user registration, safety control, information services and technological support;
- R&D on advanced instrumentation and methodology related to SR research;
- Support of the new beamline construction;
- Safety regulations.

Some basic data about SPring-8 can be found in table 5.23.

Electrical Engineering

Synchrotron radiation is extremely powerful light which is used for studying the structure of matter at the atomic and electronic levels and in various physical and

Size:	The SPring-8 site covers 141 hectares
Number of employees:	1,051
Turnover:	¥13.266 million
Location:	1-1-1 Kouto Mikazuki-cho Sayo-gun Hyogo 679-5198 Japan
Process description:	SPring-8 is a third-generation large-scale synchrotron radiation facility for research and experiments using synchrotron radiation (synchrotron light) emitted from a high-energy electron beam.
Main relationship with other organizations:	SPring-8 is under the jurisdiction of Japan's MEXT (Ministry of Education, Culture, Sports, Science and Technology). The Japan Atomic Energy Research Institute (JAERI) and RIKEN (The Institute of Physical and Chemical Research) constructed SPring-8, and the Japan Synchrotron Radiation Research Institute (JASRI) has been managing and operating it.

Table 5.23: Basic data SPring-8 [39, 40]

chemical processes in a number of research fields ranging from materials science to life science.

SPring-8, which is the largest third-generation synchrotron radiation facility in the world, provides the most powerful synchrotron radiation currently available [40].

Utilization of the features of the SR beam [41]

1. With the use of the microbeam, diffractometry of very small samples and microscopy with high spatial resolution are carried out;
2. Time-resolved experiments are conducted on various time scales using the pulsed beam;
3. Energy tunability of the beam is effectively applied, for example, to crystal structure analysis using anomalous dispersion;
4. By making use of the highly collimated beam, various types of imaging techniques with high spatial resolution are developed;
5. The linearly / circularly polarized beam is used especially for studies on the magnetic properties of materials;
6. The availability of the high energy X-ray beam enables high-Q experiments, Compton scattering, excitation of high-Z atoms and nuclear excitation of isotopes;
7. With the use of the highly coherent beam, X-ray phase optics and X-ray interferometry are studied.

Application of SR at various scientific and technological fields

Synchotron radiation is very useful for various fields in both basic and applied research. Synchotron radiation available in SPring-8 is applied to the following advanced research fields [41]:

- Life Science:
  Atomic structure analysis of protein macromolecules and elucidation of biological functions. Mechanism of time-dependent biological reactions. Dynamics of muscle fibers;
- Materials Science:
  Precise electron distribution in novel inorganic crystals. Structural phase transition at high pressure and high or low temperature. Atomic and electronic structure of advanced materials of high Tc superconductors, highly correlated electron systems and magnetic substances. Local atomic structure of amorphous solids, liquids and melts;
- Chemical Science:
  Dynamic behaviors of catalytic reactions. X-ray photochemical process at surface. Atomic and molecular spectroscopy. Analysis of ultra-trace elements and their chemical states. Archeological studies.

- Earth and Planetary Science:
  In situ X-ray observation of phase transformation of earth materials at high pressure and high temperature. Mechanism of earthquakes. Structure of meteorites and interplanetary dusts;
- Environmental Science:
  Analysis of toxic heavy atoms contained in bio-materials. Development of novel catalysts for purifying pollutants in exhaust gases. Development of high quality batteries and hydrogen storage alloys;
- Industrial Application:
  Characterization of microelectronic devices and nanometer-scale quantum devices. Analysis of chemical composition and chemical state of trace elements. X-ray imaging of materials. Residual stress analysis of industrial products. Pharmaceutical drug design;
- Medical Application:
  Application of high spatial resolution imaging techniques to medical diagnosis of cancers and capillaries;
- Nuclear Physics:
  Quark nuclear physics by GeV photons, stronuclear process and photo nuclear reactions by MeV photons.

Innovation process

The development of new science is strongly related to the development of new experimental techniques or new instrumentation. High-quality synchrotron radiation from SPring-8 has opened new scientific fields.

Japan Synchrotron Radiation Research Institute (JASRI) calls for research proposals twice a year for those that are interested in using the public beamlines. The Proposal Review Committee reviews the proposals and beam time is allocated for proposals that are approved.

There are two types of research at SPring-8. One is non-proprietary research, in which users are not charged for their beam time if they disclose their research results. The other type is called proprietary research, where users are under no obligation to disclose their results but required to pay the beam time fees in proportion to the beam time allocated for them.

Non-proprietary research is further categorized into three groups: general proposal, urgent proposal and long-term proposal, while proprietary research consists of two categories: general proposal and time-designated proposal [40].

5.6.2 Akita Research Institute of Advanced Technology (AIT)

After our visit to the Akita Research of Advanced Technology the author of this piece of the final report found himself thinking about the unusual nature of AIT. We are accustomed to institutes which form the link to academia and industry.

Regarding this point, AIT is no different than the institutes known to us. The unusual thing about AIT is that it has shown us how to really stimulate technological innovation.

The main mission of the Akita Research Institute of Advanced Technology is to promote research and development in electronics, electro-mechanics and materials development. This main mission is achieved by a twofold of goals, being the following:

- Promote the production of technology by lending support to local technology companies. This support is done by renting lab space and giving support in the field of Human Resources;
- Do research in the field of perpendicular magnetic recording.

The basic data about the Akita Research Institute of Advanced Technology can be found in table 5.24.

Number of employees:	24 researchers and 8 office staff
Turnover:	¥6,520,000,000
Location:	Akita
Process description:	Promote research and development in electronics, electro-mechanics and materials development. Focus is on technologies impacting local industries in Akita. The second part AIT plays in the innovation process is it's own research into ultra-high density perpendicular magnetic recording.
Relationship other organizations	AIT Has 6 laboratories to rent for high-tech startup companies. These companies will be under leadership of AIT.

Table 5.24: Basic data AIT

Electrical Engineering

The company website states the official objectives of AIT being the following:

Promoting research and development in the field of electronics, electro-mechanics and materials development, working with industry, academia and the prefectural government. It also promotes Joint Research and "Human Resource development" for local industries. [42]

The activities are threefold [42]:

- *Pioneering Research and Development*
  AIT functions as a public research institute to promote original research in technology areas of high potential for future growth of the local industry, as well as themes that are expected to have wide ranging effects on industry in Akita. AIT is presently carrying out the research on an ultra-high density perpendicular magnetic recording system in co-operation with the Research Institute of Electrical Communication of Tohoku University and Prof. Shunichi Iwasaki, President of Tohoku Institute of Technology, who is the inventor of the system and honorary director of AIT.

- *Joint Research*
  AIT hires out 6 open laboratories to enterprises that are going to do research and development of new technologies with cooperating academia, and under the leadership of AIT. AIT is also offering research equipment so as to support industrial development.

- *Human Resource Development*
  AIT uses On the Job research Training for engineers in industries and research. "Cutting-edge technology seminars" as well as various types of workshops are organized with the co-operation of the Akita Technopolis Foundation.

Innovation process

Because this institute has two major goals, the innovation process has two sides as well. These are, as said before, the promotion and development of local technical industry on the one hand and research into perpendicular magnetic recording on the other hand. The research in the field of high-density perpendicular magnetic recording entails similair topics, for example thin film magnetic recording heads and recording performance characterization.

Development of local technical industry

AIT hires out high-tech lab space for a very low price. The price is very low because of the funding from local government. This way, venture technological businesses (not to be confused with spin-offs) can conduct their research and are involved in their own innovation process. Giving small local companies access to expensive high-tech laboratories for a low price is the biggest thing AIT does for the local technological industry. The profit of patents these small companies attain is for their own benefit. AIT does not benefit (disregarding the small fee for the laboratories) from their customers.

In addition to that, AIT also provides consulting services to interested local industries. Local industries might not have the experience in promotion and management of their research activities. In this field, AIT helps these companies. Furthermore, AIT organizses training seminars and conferences to put Akita on the technological map. Education is also provided for the local industry. This entails on-the-job training sessions and other specialized training programs. This way local technological businesses are helped with their human resource development.

In a summary, here follows a list of things AIT does to enhance the development of the local technical industry:

- Hiring out lab high-tech lab space for a low price;
- Consulting services;
- Promotion of technical activities through seminars and conferences;
- Human resource development. This entails educational and specialized training programs.

Research in perpendicular magnetic recording

This subject was chosen by a friend of the local vice-governor, who was a professor in this specific field. The goal of the research is the obtaining of patents. If perpendicular magnetic recording is achieved, the engineering and production of this system will not be done by AIT. Patents will be obtained, which will be sold to industry.

The researchers of AIT are all full time researchers, who have been recruited through a normal application procedure. The researchers have their origin in industry, as well as university. There is little to no room for projects outside the field of perpendicular magnetic recording. Researchers are allowed, to a little extent, to research their own ideas. Almost all of the innovation at AIT is *top-down*. The chief researchers decide which direction the research is going and the rest follows.

If an innovation is done which does not fit the field of perpendicular magnetic recording, then it will be patented and sold. But since all research is done towards perpendicular magnetic recording and towards this goal only, it is very unlikely that a completely different innovation will come up.

Context characteristics

AIT was founded in November 1992 by the local government of Akita prefecture. The reason for its founding was that the Akita prefecture was behind on the production of new technology. Akita University could not be granted more funds, because Akita University is a national university and the Japanese central government was not inclined to give more funding to this university. So, to increase its technological output, Akita prefecture had to come up with another approach. What they did was simply make a large amount of money available and build AIT. It is not for nothing that AIT calls itself a "symbol of the continual industrial growth in Akita Prefecture"[43].

Akita is an example of a local government which has understood how to develop a climate in which to stimulate innovation: start an organization and back that up with money. Don't just keep talking, like we sometimes tend to do in the Netherlands.

5.6.3 The Earth Simulator Center

The Earth Simulator is the former number one super computer of the world and is developed for two aims and objectives. The first aim and objective is to ensure a bright future for human kind by predicting variable global environment accurately. The second aim and objective is to contribute to the development of science and technology in the 21st century. Based on these purposes, four principles are established to the projects of the Earth Simulator:

- Each project should be open to researchers of the same field and should not to be confined to a limited group of researchers;
- In principle, the research achievements by the Earth Simulator should be swiftly published and delivered to the public;
- The Mission Definition Committee will examine research achievements and encourage effective operations;
- Each project should be carried out for peaceful purposes only.

Some basic data about The Earth Simulator Center can be found in table 5.25.

Figure 5.5: The Earth Simulator Center

Institute name:	Earth Simulator Center (ESC)
Year of foundation:	Start of building the ESC: March 2000 Start of operation: March 2002
Number of employees:	50 (of which 30 researchers)
Turnover:	Unknown, but about 20% of the total resources is spent in Electrical Engineering related research
Location:	Yokohama
Main operations:	The Earth Simulator Center is a super computer. It facilitates research for several purposes. Users from all over the world can make use of the ESC.
Main relationship with other organizations:	The research projects conducted at the Earth Simulator Center are actually carried out at different centers and institutes. These are: - Japan Marine Science and Technology Center; - Frontier Research System for Global Change; - Institute for Frontier Research on Earth Evolution; - Japan Atomic Energy Research Institute; - Center for Promotion of Computation Science and Engineering; - The Earth Simulator Center. Also, there is a lot of cooperation with various high schools and universities.

Table 5.25: Basic data Earth Simulation Center [44, 45]

Electrical Engineering

At the beginning of each year, there is a public project recruitment for the Earth Simulator Research Projects. In the year 2003, 34 research projects were accepted out of 53 proposals. There are four fields of the Earth Simulator Research Projects, as follows:

- Atmospheric and oceanic simulation (35% of resources);
- Solid earth simulation (20% of resources);
- Computer science (10% of resources);
- Epoch-making simulation (15% of resources).

Electrical engineering topics are to be found in the computer science section and in the epoch-making section. The following subjects are of our interest [44]:

Computer science

- Design and implementation of parallel numerical computing library for multi-node environment of the earth simulator;
- Performance evaluation of large-scale parallel simulation codes and designing new language features on the HPF (High Performance Fortran) data-parallel programming environment.

Epoch making

- Numerical simulation of rocket engine internal flows;
- Development of the next-generation computational solid mechanics simulator for a virtual demonstration test;
- Large-scale simulation for a THz resonance superconductors device;
- Geospace environment simulator;
- Particle modeling for complex multi-phase system with internal structures using DEM;
- Development of transferable materials information and knowledge base for computational materials science;
- Cosmic structure formation and dynamics;
- Bio-simulation;
- Large scale simulation on the atomic research.

During the study tour, the next researches were presented:

- Various simulations from the field of Global Ocean and Atmosphere;

- Various simulations from the field of Solid Earth.

Both groups of simulations are not really in the field of Electrical Engineering, nevertheless they were good examples of the research conducted at the ESC and they showed impressive resultst.

Innovation process

The Earth Simulator Center is an innovation itself. The question for a supercomputer like the ESC should lead to new innovations concerning the design of the computer, but in this case the demands were so specific that NEC was the only company who saw the opportunity to satisfy the demands. In that way, no competition between different companies could occur, which may have lead to less innovation. Besides of that, the building of a super computer is still an impressive and innovative project.

In 2002, three results of research using the Earth Simulator earned the award in the categories of "Peak performance based on operations per second" and "Special accomplishment based on innovation", so innovative research is also conducted at the ESC [46]. There is some kind of competition going between the most powerful computers in the world. Nowadays, the ESC is not the world leader anymore, but they don't really care, because they are still on top of the list considering peak performance and they consider actual use to be more important than peak performance. The ESC is very good on vector calculations, but not on scalar calculations. This competition feeling may lead to new innovations but right now this is not the case.

Because the ESC is a research institute, there is nothing that can be said about core technologies, management structures, in- and outsourcing, spin-off enterprises, technology push versus market pull and sustaining versus disruptive technology developments. However, there is something that can be said about the environment. A subpart of environment is "governmental regulations". The ESC is founded by the government. Also, the government paid until recently all the costs of the research conducted at the ESC. However, there are regulations which inhibit the technological innovation at the ESC. For instance, there are projects at the ESC which can generate weather predictions, but they are not allowed to publish them because the government dedicated already an other institute to generate and publish the official weather predictions.

Context characteristics

Relevant macro characteristics

At the ESC, it seems that the geographical properties of Japan are not a restriction: research at the ESC is even conducted from France: the researchers do not have to move to Japan to conduct their research, they just make use of the international network which the ESC is connected to. The government supports but also inhibits research conducted at the ESC. They support research by giving the order to build the ESC back in the nineties, paying the maintenance of the ESC and paying its personnel so research conducted at the ESC was for free. Unfortunately, this is no longer the case. Until recently, research conducted at the ESC had to satisfy a few demands, listed in the introduction. Every research had to fulfil these demands, but along with the switch from free research to paid research, these demands are put apart. This both has advantages and disadvantages for innovation: because research does not has to be published, the ESC can also be used for more confidential research which often is more innovative. On the other hand, because companies have to pay for their research, not every research can be done anymore, which could inhibit innovation.

Relevant meso characteristics

The designers of the Earth Simulator Center had to take into account that earthquakes could occur. They have overcome this problem by building the entire building on rubber shock dampers, that absorb earthquakes up to a level where other buildings would collapse. The extra costs were payed by the government.

In the preliminary report it was stated that Japan is more focused on applied research instead of basic research. The ESC facility is especially suitable for basic research. It is a large computer, capable of doing massive calculations which could be very useful for basic research project. However, it seems that the ESC is more often used for applied research, concerning simulations of different natural events of the earth, simulations of car accidents and so on. Nevertheless, the ESC is also used for research concerning nano technology, proteïn technology and so on.

Overall, the research can be divided into five different parts as stated before: Ocean and Atmosphere(35%); Solid Earth(20%); Computational Science(10%); Epoch making(15%); Director-General Discretion(20%). In general it can be said that computational science research and epoch making research is basic research, while the others are more applied. These two parts are only 25% of the total research conducted at the ESC.

Moreover, it was stated that in Japan, more money is spent by the government on R&D than in the Netherlands. This becomes clear when looking at the way the ESC is financed: the government not only paid for the development and building of the ESC, they are also paying for the research conducted at the ESC (at least until now: for the next years, companies have to pay the research for themselves). The ESC has a few connections with universities different universities: the university of Tokyo, Nagoya university, Kyoto university, Kyushu university, university of Tsukuba, Chiba university. Also, there are contacts with different graduate schools.

5.6.4 Research Institute of Electrical Communication (RIEC)

The Research Institute of Electrical Communication was founded in 1935 at the Faculty of Electrical Engineering of Tohuko University. It was at that time that the Faculty of Electrical Engineering started to make its mark as a body of scientists undertaking pioneering research into electrical communications. Since then, RIEC has continued to excel as the only research institute affiliated with a national university that is active in the area of the "theory and application of intelligent information science and communications", across various fields, with a range that includes both hardware and software.

Number of employees:	
regular staff	123
part-time and extramural researchers	81
students	305
Budget of 2003:	
Personnel expenditure	1.109 million yen
Supplies Expenditure	942 million yen
Research Grant:	
Ministry of Education, Science and Culture (MEXT)	390 million yen
Partnership between Universities and industry	1.253 million yen
Total	3.694 million yen
Location	Campus of Tohoku University, Sendai
Process description	The Research Institute of Electrical Communication is a unique university-run research institute in Japan that is dedicated to the research on communication and information processing.
Main relationship with other organizations	The Institute is responsible for organizing Nation-wide Cooperative Research Projects by coordinating its activities with research workers in the field of information science and communication technologies and systems.

Table 5.26: Basic data RIEC

Electrical Engineering

The Research Institute of Electrical Communication is a unique university-run research institute in Japan that is dedicated to the research on communication and information processing. It comprises four research divisions with 25 subsections (including 4 visitor subsections) and three research facilities with 13 subsections. Each subsection is being headed by a professor. In 1994 the institute was designated as National Center for Cooperative Research aimed at the realization of "barrier-free communication" technology.

Since its establishment in 1935 the institute held an international leading role in the fields of microwaves, ultrasonics, magnetic recording, optical communication, acoustic communication, semiconductor devices and information theory. The accomplishments in these fields are the fruits of close cooperation with the faculties of Engineering at Tohoku University.

The three research facilities of RIEC are focused on short, medium and long-term projects.

The Research Centre for 21st Century Information Technology was established in 2002 with the purpose to develop practical technologies for IT, based on the advanced technologies of RIEC with the partnership among industry, government and university. The term of development is limited to less than 5 years. The goal of the projects is to match the basic research of the university with applications in the industry. The combination should lead to new practical technologies for commercial products.

An example of a project which is currently running at this facility is the development of ultra small and high capacity hard disks using the technology of perpendicular magnetic recording. Another project is the development of a wireless system for the "Ubiquitous Network". This is a network that connects almost all electronic devices so you can control them everywhere and at any time. Both projects are funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and are in collaboration with at least 5 different companies.

The Laboratory for Nanoelectronics and Spintronics is focusing on medium-term projects. This facility was built in 2004 and has 1600 square meters of cleanroom area. It is carrying out fundamental research into high speed semiconductor devices and advanced nano/spin science. Non-volatile memories, smaller and faster electronic devices and molecular bio-information devices are some of the expected fruits of this research.

The Laboratory for Brainwave Systems has a long-term goal. This facility was established in 2004 with the purpose of contributing to the research and development of advanced information science and technology for brainwave systems. These systems will realize a seamless fusion between the virtual and the real world at the human-computer interface.

Innovation process

As mentioned before RIEC has different divisions and many sub-divisions. Therefore there is a very wide range in research topics. A lot of the research projects are done in cooperation with industry. Many researchers at RIEC are coming from companies.

Often the collaborations between RIEC and industry lead to a technological breakthrough. The company will usually get the patent on it. In case the company does not want the patent or the innovation isn't done in cooperation with another company, the university takes the patent.

RIEC shows, as other Japanese institutes do, a great interest in patents. The surprising thing is that, as far as we can see, not much is done with these patents. At RIEC there are no plans whatsoever to translate this technological advantage, in the form of a patent, into a product or a venture business. If a researcher wishes to start his/her own business to translate the new technology into a product, this has to be done without support from RIEC.

Most of the research devisions at the Research Institute of Electrical Communication is dealing with innovation in one way or another. Two striking examples of (sub-)divisions that are innovative are the Contribute Research Division and the Research Center for 21st-century Information Technology. The Contribute Research Division is at the moment, together with Hitachi Ltd., working on next generation information technology.

The purpose of the Research Center for 21st-century Information Technology is development of practical technologies for IT based on the advanced technologies of RIEC with the partnership among industry, government and university. The term of development is limited to less than 5 years. The projects are planned on matching with both basic technologies in the university and application in the industry. Combination of the technologies of the university and industry makes practical technologies with availability for commercial products. The center actively accelerates to obtain the intellectual properties generated from the development of practical technology to the industry.

Context characteristics

The Research Institute of Electrical Communication sees itself as a “National Centre of Cooperative Research”. The institute works in cooperation with university, industry and government. These relations are visible on different levels.

First of all the Research Institute of Electrical Communication maintains a close relationship with the Graduate School of Engineering and the Graduate School of Information Sciences in its research and educational activities. About one third of the students of the faculties of engineering are doing research at the institute. This cooperation enriches the research activities of RIEC.

The institute also organizes nation-wide cooperative research projects by coordinating its activities with research workers. The main themes for cooperative research are selected annually by the committee for cooperative research. After that invitations for project proposals and participation are extended to university faculties and government laboratories as well as industrial research groups.

About 11 percent of the budget of RIEC comes from the Ministry of Education, Culture, Science and Technology (MEXT). MEXT focuses on basic and fundamental research and development activities of a comprehensive nature which goes beyond the jurisdictions of individual ministries and various categories in order to make contributions to a wide range of areas. One of those areas is the realization of an information society. This is an area which the Research Centre for 21st Century Information Technology is engaged in. The current projects of this facility are therefore funded by this ministry.

The largest part of the research grant of RIEC, about 76 percent, is coming from the partnerships between RIEC, universities and industry. This money is one third of the total budget of RIEC.

5.6.5 Institute of Industrial Science

After World War II Japan needed to get its industry back online. This was one of the reasons why the Institute of Industrial Science (IIS) was founded. The Institute of Industrial Science at the University of Tokyo was founded as one of the research establishments of the University at Yayoi-cho, Chiba-shi, (these are districts in Tokyo) in 1949. ISS was moved to Azuba Shinryudo-cho (Roppongi) in 1962 and later on it was moved again to Komaba Research Campus in 2001.

The Institute of Industrial Science is the largest institute at the Tokyo University and covers all engineering fields. The institute currently has approximately 300 staff members, three major divisions (material and life science, information and systems, human and society). IIS also has six research centres in the research department and covers 57 research areas. The members of the facility do not only concentrate on research but they also play an active role in education by means of courses, research meeting etcetera. The ISS consists of 10 faculties, 11 institutes and 14 graduate schools. The institute also offers master and doctor courses. The faculties at ISS are respectively Law, Medicine, Engineering, Letters, Science, Agriculture, Economics, Arts and Science, Education and Pharmaceutical Sciences. This broad range of faculties all cooperate in research and education.

Electrical Engineering

The Institute of Industrial Science is not exactly the same as Electrical Engineering at the University of Twente. It is more a kind of institute where research is done in all engineering fields. There are three laboratories that we visited at IIS: Hashimoto lab, Fujita lab and Kawakatsu lab. In this topic a summary is given in which areas the laboratories are researching.

Number of staff members:	300
Number of students:	approx. 600
Turnover:	The IIS receives basic research budget as well as special research subsidy. Which is granted on the basis of proposals by individual researchers (from the Ministry of Education, Science, Sports and Culture) and additionally from industry as cooperative research fund, entrusted research fund and research promotion fund. The Institute has a unique system of sharing a portion of its total budget and reserving it for selective awards for junior academic staff.
Location:	University of Tokyo Komaba Campus
Process Description:	Since the foundation of IIS, the institution has realized a two-footed approach by ”going beyond basic research an bringing about fruitful practical technologies” and playing a leading role in forcing alliances with society and cooperation between industries and academia.
Main relationship with other organizations:	here are different ways in which ISS is related to other organizations or industries. The easiest connection and also main connection is Tokyo University. IIS is the largest institute en gets a big amount of funding from Tokyo University. But there are also other connections with the Industry. IIS realizes that there has to be cooperation between industry and University. So they have started different programs to promote cooperation. A few examples are Collaborate Research with industries and Entrusted research.

Table 5.27: Basic data IIS

Salaries and wages:	¥3.057.459.517
Research equipment and others:	¥2.090.586.557
Research subsidy from Ministry of Education, Science, Sports and Culture:	¥1.117.773.000
Research Promotion Fund:	¥279.889.743

Table 5.28: Budget IIS 2001

Hashimoto Lab

The research in Hashimoto Lab is mainly conducted in three research areas respectively Intelligent Space, Intelligent Transportation, Micro Telemanipulation.

1. *Intelligent Space*
   Intelligent space is space with functions that can provide appropriate services for human beings by capturing events in the space and by utilizing the information intelligently with computers and robots. Robots with partial intelligence become more intelligent through interaction with the space. Moreover, robots can understand the requests (e.g. gestures) from people, so that the robots and the space can support people effectively.
2. *Intelligent Transportation*
   With the present state of technology, there are many systems in which it is possible to measure or collect a significant amount of data, and also derive a mathematical model for the system. The proposed framework would enable increase in the application domain of estimation algorithms allowing the use of these data to learn such system parameters (including the system noises parameters), and “complete” the model that may be used in inference algorithms. Various filtering algorithms (named generically as particle filters) for non-linear, non-gaussian model states estimation have been recently investigated. These filters allow inference of more “general” structure system. However, in the case of high dimension models, it is difficult to realize realtime filtering. Another theoretical work has proposed/investigated a new Rao-Blackwellisation particle filter based algorithm for real-time applications.
3. *Micro Telemanipulation*
   In micro telemanipulation, visual information of a microenvironment is usually caught by microscope. It is difficult to manipulate micro objects for a human operator based on single visual information. Getting 3D geometry information of microenvironment is indispensable to human dexterous manipulation. However, space and cost problems make it difficult to use two or more microscopes, and they still do not provide enough information for human dexterous manipulation. In manipulation, the haptic feedback is very

important for human operator and it is the reason why a haptic interface is adopted to tele-micromanipulation systems. Haptic feedback is feedback that is directly connected to human sense like feeling. Pressure sensors are used to indicate a pressure on a surface. Another example is a virtual wall. A person wears a glove or a robotic arm that moves up until a certain virtual surface and then freezes like when you hit you are arm against a wall. It is comparable to force-feedback in a joystick.

Fujita Lab

At Fujita Lab research is mainly based on Micro and Nano Electro Mechanical Systems (MEMS/NEMS). Two of the most recent developments are described below.

1. *Bio-Molecular Hybrid MEMS/NEMS*
   In this project the objective is to establish a bio-hybrid system in which biomolecular motors and Micro/Nano Electro Mechanical Systems (MEMS/NEMS) are integrated. Since biomolecular motors such as actin-myosin, kinesin-microtubule, etcetera are of nanometers in size, they can work as real nanoscale actuators in MEMS/NEMS devices. Fujita Lab has successfully realized the patterning technique of rail molecules, transport of micro machined structures by kinesin-microtubule system, on/off control of motors, and unidirectional transport.
2. *Nano Metric Twin Probes*
   By using silicon micromachining technologies. Fujita lab fabricated twin probes having dimensions of 5 micrometers in length and 100nm in width. Each probe could be driven independently by integrated thermal actuators in a transmission electron microscope. The initial gap between the probe tips was 400nm and could be completely closed.

Kawakatsu lab

Kawakatsu lab concentrates its research mainly on the AFM (Atomic Force Microscope). With this AFM, molecules and even atoms can be made visible just like an electron microscope, but more precise. This is why Kawakatsu lab is specialized in research areas like applied scientific instruments, nanomechanics, scanning probe microscopy-microscopy and visualization of extremely small objects and also measurement and control in the nanometer region. Some projects that Kawakatsu lab is currently working on, are the following.

1. *Fabrication of Nanometric oscillators for detection of force and mass*
   Various types of nano-oscillators were fabricated by silicon micromachining techniques. Their natural frequencies lie in the range of 1 MHz to 1GHz, spring constant 0.001 N/m to 100 N/m. Various cantilevers can be tailored to suit a wide range of target applications. A novel AFM optical head with

heterodyne laser Doppler interferometry up to 200 MHz was implemented. For a 100 MHz cantilever, thermal-noise limited mass resolution reach 10-23 g.

2. *Characterization of three dimensional nanometric objects*
   A SEM-AFM and a laser Doppler interferometer with optical vibration excitation functions were implemented. The former was used to measure static mechanical characteristics. The latter enabled measurement of vibration modes and Q factor of cantilevers measuring as narrow as 100 nm, at frequencies up to 200 MHz.
3. *Millions of cantilevers for parallel AFM operation*
   Various optical detection and excitation schemes are studied to implement simultaneous or sequential detection of millions of cantilevers.
4. *Metrological application of crystalline lattices*
   Researchers have succeeded in counting atomic lattices at a rate of up to 100kcounts/s, or a velocity of around 20 μ m/s. Higher count rate can be realized by using cantilevers with higher natural frequency. Application of a compliant nanocantilever is in preparation.
5. *Mapping of sub atomic lateral vibration of the tip in atomic force microscopy*
   Self-excitation of torsional resonance of an AFM cantilever was implemented to realize resonance tracking lateral dissipation imaging. Nanometric features of self assembled monolayers were resolved, and contrast was seen on different SAM domains.
6. *True atomic resolution Non contact lateral force microscopy*
   A commercial non-contact mode silicon cantilever was put to torsional resonance. This was accomplished by positioning the laser spot of a laser Doppler interferometer at one longitudinal edge of the cantilever. Stable self-excitation of torsion was possible at 1.6MHz to 2 MHz(depending on the cantilever) with an amplitude of 0.1 nm. True atomic resolution was obtained on Si_{111} 7 x 7.
7. *“Nanopiano” an array of cantilevers for detection and imaging*
   Laser spots of a Doppler interferometer with an optical excitation function was scanned with a telecentric microscope and galvanoscanners. Frequency and Q factor are automatically acquired by a digitally signal processed mirror/frequency scanner and a network analyzer.
8. *A nanocantilever TEM-AFM for in-situ mass measurement*
   A laser Doppler interferometer optical probe measuring 2mm in diameter was designed to fit between the upper and lower yokes of an UHV transmission electron microscope. TEM visualization of atom and molecule switching and simultaneous mass measurement with a nanocantilever is in preparation.

Innovation process

Every laboratory will be highlighted in its own paragraph. At the end the IIS as a whole will be described.

Hashimoto lab

To see how innovation is realised at Hashimoto Lab an individual analysis will be made on the three different research areas.

1. *Intelligent Space*
   The Intelligent Space can physically and mentally support people using robot and VR technologies; thereby providing satisfaction for people. These functions will be an indispensable technology in the coming intelligence consumption society.
2. *Intelligent Transportation*
   Research has been conducted mainly in the field of nonlinear estimation algorithms and their applications to real systems. The developed algorithms are expected to have wide applicability, being useful in any system that would benefit from increase in inference "precision". Research on these algorithms application, and development of advanced algorithms for particular systems has also been actively conducted. These investigations have been related with automotive systems. Recently development focused on advanced signal processing algorithms for GPS (Global Positioning System).
3. *Micro Tele manipulation*
   In recent years, the interest in multi-modal based collaboration systems has been continuously increasing. This is also known as CSCW (Computer Supported Collaborative Work) technology, which realizes easier collaboration among distributed work groups. However little attention has been given to the multimodal collaboration with physical contact.

From the analyses of all three research areas we can conclude that innovation in Hashimoto Lab is mainly based on finding new trends/desires in society and applying new techniques to fulfill these desires.

Fujita Lab

Fujita Lab claims to be a pioneer in the field of optical MEMS, in which micro electromechanical structures are used for interacting with light beams travelling in free-space, and by which they have demonstrated various opto-mechanical devices such as fibre optic switches, variable optical attenuators and spatial light modulators.

For MEMS, research of more than ten years has turned a corner now and it has come to a new stage. Fujita Lab is developing commercial products such as fibre optic devices and projection displays. In this sense, they are actively co-working with industry to transfer their micromachining and micro actuator technology, in which they also learn a lot from these industries to foresee technological demands in future. As for the university mission, it is now another new phase to anticipate new leading technology by deliberately conducting fundamental research.

Kawakatsu lab

Professor Hideki Kawakatsu's comment on the topic of innovative research is: "About innovative research. I think the young students should be brought up in an environment where they feel free to try out an experiment on their own, or do a little modeling and calculation. Also important are learning teamwork as well as 'single-work'. I often hear that it is important for a young researcher who is just starting up, to 'taste the taste of success' as early as he/she could. After that, the researcher feels more confident and is ready to bite into a project of more larger and profound character, and is able to persevere times of difficulties."

Institute of Industrial Science (IIS)

According to IIS Universities are sites for creation and accumulation of knowledge based on free-thinking minds, as well as vehicles to "meet social challenges and devise solutions" from a comprehensive view point.The special feature of the institute's research framework is the way in which it fosters international comprehensive engineering.

The institute fosters research based on flexible ideas without being constrained by a particular field, fosters interdisciplinary research groups and organizes international research centres to meet challenges which require more concentrated research efforts. In order to carry out research comprehensively. The concept of 'fostering' runs through all activities of the institute. An example of this is the special research committees for creating social alliances and cooperation between industry and academics.

IIS is also striving for open cooperation through regular events such as open house, press conferences and forums. Moreover they are making an effort to realizing comprehensive research education as a feature of the university by cooperating not only with engineering research courses close to the institute but also with other departments at the University of Tokyo.

Context characteristics

Most of the funding at IIS is paid by the government. There are also contracts with companies which allow an extra income. Another source of income for the laboratories are the patents that are attained.

5.6.6 MESA$^+$

MESA$^+$ was formed in 1999 as the merger of two institutes: MESA and CMO. It goal remains to do excellent research and train researchers in nanotechnology and related areas and to create economic spin-off activity. MESA$^+$ uses a select number of Strategic Research Orientations and active business development to archieve these goals.

These choices have proven their value. MESA+ has shown a stepwise increase in output (Ph.D students, externally funded projects) and continues these levels. It has archieved considerable national and international visibility and impact. Its concept is used as a bestpractice example for research organizations in other places.

MESA+ started in 1999 with a start-up grant from the University of Twente. This, in combination with the quality and continuous dedication of the MESAns, formed the basis for the current success [55].

Number of employees:	450
Turnover:	€33,000,000
Location:	Campus University of Twente, Enschede
Process description:	MESA+ focuses on Nanotechnology based on its underlying strengths in material science, microsystem technology, bottom-up chemistry, optics and systems.
Main relationship with other organizations:	Largest research institute of the University of Twente

Table 5.29: Basic data MESA+ [55]

Innovation process

MESA+ focuses on Nanotechnology based on its underlying strengths in materials science, microsystem technology, bottom-up chemistry, optics and systems. Its mission is to:

- Excel in its field of science and technology;
- Educate researchers and designers in the field;
- Build up fruitful national and international cooperation with industry and fellow institutes.

MESA+ is a research school, designated by the Royal Dutch Academy of Science.

MESA+ has defined the following indicators for achieving its mission:

- Scientific papers at the level of Science, Nature, or journals of comparable stature;
- 1:1 balance between university funding and externally acquired funds;

- Sizable spin-off activities.

MESA+ has a matrix structure in which scientific disciplines, led by a responsible professor, are combined with strong and ambitious multidisciplinary programs, the Strategic Research Orientations (SROs), which aim at the various aspects of Nanotechnology.

The creation of SROs ensures a strong multidisciplinary activity within the institute and is a basis for realization of its goals. An SRO is a large scientific program (in the order of 30-35 full-time researchers), which satisfies the following criteria:

- Combining high-quality research of at least five groups within the institute into a genuine multidisciplinary program;
- Providing excellent opportunities for international top-level research;
- Attractive for external funding (which is a quality indicator in its own right).

A Program Director is responsible for the scientific coordination of each SRO. The Program Director is directly responsible to the Scientific Director of the institute. The SROs will be evaluated every two years, based on the criteria mentioned above. MESA+ will use its external reviewers (e.g. Scientific Advisory Board, the technology foundation STW, or others) for this evaluation, which can result in (dis)continuation of the program. In case of discontinuation, MESA+ will only fund salaries of existing Ph.D.'s and post docs for the remainder of their appointment. The SROs cover approximately 70% of MESA+ research. This activity is completed by disciplinary research, which has an important role in the further development of each research group's disciplinary activities and strength (founding research), in the exploration of new fields (potentials), etcetera. This research is referred to as Complementary Research.

Most new ideas which occur at MESA+ can be commercializated by forming a spin-off. The commercialization activities of MESA+ were increased successfully, even in economically adverse times. Spin-offs around the institute showed continued growth. New ventures were formed. To further support the growth of economic activities around MESA+, an on-campus incubator was built next to the MESA+ central labs. it allows (parts of) young companies to develop, close to the research institute in an entrepreneurial setting, leading to intensive informal contacts. Such a bottom-up approach (the so-called coffee-table and lab-floor approach) leads to a healty and challenging atmosphere and a growth of the number of entrepreneural initiatives [55].

In 2001, MESA+, together with DIMES (Delft) and BioMade (Groningen), took the initiative to create a nationwide nanotechnology programme called NanoNed. In 2002, after intensive discussions between the eight institutions involved, the initiative matured to become a comprehensive national programme [55]. Frontiers is a network of excellence supported by FP6 of the European Commission with a focus on life sciences related nanotechnology. The network consortium consists of a selection of the best groups in nanotechnology that Europe has to offer in this area.

Frontiers creates centres of excellence in science as well as facilities. Main elements of Frontiers are aimed at increasing the efficiency of research, infrastructure, education and at building more and better business cases. A number of 192 researchers and staff scattered throughout Europe will be integrated in the Frontiers network during the next four years.The coordinating party is MESA$^+$ [56].

MESA$^+$ is also a member of the "Micro And Nanotechnology Commercialization Education Foundation" (MANCEF) and MESA$^+$'s technical-commercial director, Kees Eijkel, is currently the president of MANCEF. MANCEF is the global community of all people and organizations that have an interest in commercializing miniaturization technologies, and COMS is MANCEF's yearly meeting place. One of MANCEF's key activities is to identify the activities that our community could profit from, initiate them if needed, and bring them to a global level. MANCEF's International Micro-Nano Roadmap is a pivotal activity in this respect. In the past year, a tremendous effort has been made by the MANCEF members to develop a 2nd Edition, creating 5 completely new chapters on key issues and renovating several chapters from the existing 1st Edition Roadmap. The 2nd Edition Roadmap was pre-released during COMS and since then proves to be a "must-have product" [57].

5.6.7 TNO

TNO was established by law in 1930 to support companies and governments with innovative, practicable knowledge. As a statutory organization they have an independent position that allows them to give objective, scientifically founded judgments.

TNO is a knowledge organization for companies, government bodies and public organizations. They provide contract research and specialist consultancy as well as grant licenses for patents and specialist software. TNO tests and certifies products and services, and issues an independent evaluation of quality. They also set up new companies to market innovations.

As a contract research organization, TNO translates the results of fundamental research into practical applications on a commercial basis. This implies that they maintain close relationships with the academic world in which new knowledge is generated. They also maintain close relationships with industrial R&D labs and companies where knowledge is applied to products and processes.

Electrical Engineering

The fields in which TNO oparates are divided into five core areas:

Number of employees:	>5000
Turnover:	€553,000,000
Location:	TNO has locations throughout The Netherlands. The largest offices are in Apeldoorn, Delft, The Hague, Rijswijk and Zeist. TNO also has has representative offices in foreign countries. These are located in Japan, USA and Ukraine.
Process description:	TNO makes scientific knowledge applicable in order to strengthen the innovative capacity of business and government.
Main relationship with other organizations:	As a contract research organization, TNO works for companies all over the world as well as for local, national and supranational governments, such as the European Commission.

Table 5.30: Basic data TNO

- Quality of life.
  This sector is not of interest concerning Electrical Engineering.
- Defence and public safety.
  Defence is undergoing drastic change 'politically, technologically and scientifically. TNO identifies the impact of such changes and advises the Dutch Ministry of Defence how it can respond with the greatest effectiveness. From the latest radar applications to a more efficient operational deployment of people and resources, TNO is developing leading-edge technology and expertise for the Dutch government, NATO and the international defence industry.
- Advanced products, processes and systems.
  This sector is not of interest concerning Electrical Engineering.
- Natural and built environment.
  In a densely populated delta region like the Netherlands, spatial planning and the use of space are always high-pressure subjects. What decisions must government and business make when it comes to the sustainable use of space and the environment? TNO advises on topical issues related to the use of the subsurface, the sea, mobility, infrastructure, inner city renewal, the networking of cities, the environment and sustainable energy. TNO is also a partner in process innovation projects in a range of areas including construction. Moreover, TNO contributes to innovative logistics, transport and traffic systems. For example, with sophisticated logistics solutions for business that save money and time.
- ICT and service.
  ICT and services revolves around the smarter application of ICT so that

companies and government bodies can achieve higher returns on their investments in internet, networks and other forms of automation. But what really lies at the heart of the field is the effort to enable everyone in society to profit from an extensive, accessible network of information and facilities. E-business and e-governance 'with the e for efficiency and effectiveness. TNO helps its customers to innovate with the help of ICT: in management and services, as well as in production processes and distribution channels. TNO develops applications in the fields of operational processes, telecommunication techniques and information management and TNO possesses in-depth knowledge of information security techniques like protection of personal data. Research subjects include both human-computer interaction and technical aspects like infrastructure and hardware design.

Innovation process

Knowledge, Economy and Innovation (KEI, a department of TNO-STB, where STB stands for Strategy, Technology and Policy) is the department within TNO which strives for the gathering of reliable information and the build-up of knowledge needed for an economically viable and controllable innovation. KEI developes the knowledge which is necessary for innovation. It's clients are national and regional authorities, social organizations and companies.

KEI is active in four domains: innovation policy, life sciences, network economy and entrepreneurship. Special attention is given to the role of information and communication technology within innovation processes. KEI aims for innovation, where output and social development complement each other. The build-up of knowledge of innovation likewise features this complementary viewpoint. The global link-up of social institutions, techno-economic systems and Trade & Industry means that innocently looking decisions taken at one level may have major consequences at another.

Context characteristics

Relevant macro characteristics

The Netherlands are famous because of their international focus. TNO is an exponent of this. It is not only an institute which is very internationally focused, also its main objective is to enhance and strengthen the Dutch position on innovative products. They get a lot of support by the government and they do not get lots of restrictions by the government which can inhibit technological innovation.

Relevant meso characteristics

It is important for a company to keep knowledge within company boundaries, so to prevent a core technology from leaving the company. But some companies also have the policy of making knowledge broadly available. Considering this, TNO has a social responsibility for the developing of knowledge: TNO translates knowledge into practical applications. Within this framework knowledge is sometimes broadly available for TNO (when financed with public money) but sometimes only to be used by the customer (contract research). So within TNO some technologies are kept inside the company while others are published to the public. Important knowledge that should not 'leave' the company has been protected by the system on intellectual property rights.

As said before, TNO does both research for the public as well for companies. Research conducted for the public is open and the results are published (when financed with public money). On the other hand, research conducted for companies is not open and the results are only published to the company which gave the order for the research. Of course, the companies have to pay for that research.

For both public and contract research, TNO cooperates with different parties: in research and research related projects TNO develops new knowledge often in collaboration with other parties, i.e. with national and international universities and technological top institutes. TNO also participates in a large number of projects of the European Union's R&D programs in which they are part of international consortia.

Considering technological innovation, it is interesting to look at the way companies produce new products: are they working with completely new technologies or do they use already existing technologies for creating new products. About this subject, TNO states the following: research and the practical application of its results is an ongoing process and concerns proved technology as well as the developing of new technologies.

Although in the preliminary report it was concluded that the Dutch are more focused on basic research and that they are not that good in developing innovative products, TNO much more focused on applied research. It is not a coincidence that TNO stands for "the Dutch Organization of applied scientific research". The translation of research into practical applications is a distinguishing characteristic within the research market TNO is acting in. In every case it has to contribute to innovation, a key issue in TNO's mission, to strengthen the economic position of the Netherlands.

An example of a cause of lack of innovation is knowledge drain from a company. Of course TNO too has to deal with an knowledge drain due to leaving employees. To prevent this knowledge drain they have a HRM-policy: to hold up the employees to the company by creating a good work atmosphere and (in the case of TNO) a good scientific environment. But sometimes it is inevitable that people leave the company. In that case it is important to limit the loss of knowledge by taking care for spreading out knowledge over other employees. Besides that, employment contracts contain a competition clause, to avoid abuse of knowledge.

5.6.8 Discussion

The visited institutes in Japan can be divided into two groups: the first group contains the facilitating institutes. These are the Earth Simulator Center and Spring 8. Both institutes have a facility which is very rare and thus users from all over the country make use of it, while the institute itself does not supply the researchers. This group of institutes can be compared with MESA$^+$. The other group is more a cluster of researchers, all working on one or a few subjects. This group contains RIEC and AIT, as well IIS. This group can be compared to the Dutch TNO.

ESC, Spring 8 and MESA$^+$

There are a lot of equalities between ESC and Spring 8: both institutes have a big, governmental ordered facility. They both facilitate something very rare, not only in Japan, but also in the rest of the world. In that view, MESA$^+$ is a little bit different, because it is 'only' a facility for nano technology: it is a clean room. The similarities between the Dutch MESA$^+$ and the Japanese institutes is that all of them are working on advanced technologies which lead to innovative products.

In particular there is the similarity of focus: all of the institutes are focusing on a narrow field of technology: Spring 8 on synchrotron related research, ESC on supercomputing related research and MESA$^+$ on nano technology. Looking at the way the research is organized, one can say that at all of the institutes a proposal has to be done to gain access to the facility. Though it seems that money also opens a lot of doors. Both at the Japanese institutes, as well in MESA$^+$, research is mostly applied instead of basic.

The biggest difference between the Dutch institute and the Japanese institutes, and probably this can be generalized, is the way research is financed. In the Netherlands, money for research is obtained by doing good proposals to the government, or to the European Union. Not much funds are available. In Japan, on the contrary, research is almost always funded by the government. At the ESC, research is for free when the results are published to the public. This is also the case at Spring 8. Another difference is the relation between the institute and education related facilities. MESA$^+$ has very intense bonds with the University of Twente. It is often used by students for different assignments. This special relationship is less obvious at most the Japanese institutes we have visited.

On the other hand, if we look at institutes as ISS and RIEC, we see that they employ a lot of students and these institutes are located near universities. The location of Spring 8 is in that way not very handy: no big educational institution is located near this institute. This is also the case at the ESC, but the ESC can be controlled from anywhere around the world. At the ESC, researchers from French universities are working, but again: the relation is less close than between MESA$^+$ and the University of Twente. It is hard to say if this is in general the case. But it seems though that the Dutch are more thinking about where an institute can be set up: they are more placing institutes at places where other knowledge is also available.

RIEC, AIT, IIS and TNO

In the previous part it was stated that it seemed that the Dutch are more thinking about where to place an institute while the Japanese do that different. This is also the case with AIT: this institute is not located near a lot of big companies. Local government thought that more jobs and technological output was needed, so AIT was founded. In the view of the Japanese, the founding of an institute like this is almost everything you need to generate new products and technologies.

It is hard to compare IIS with other institutes, because of its large size: it contains not only research parts, but also an educational part. The similarity between IIS and TNO is that both institutes are doing research in the general way, however at IIS this is extremely the case. TNO is often working with contract researches, but this is also the case for RIEC. AIT and RIEC are somewhat different in the choice of research field. They decided to focus on a few subjects, instead of doing research on all possible fields.

The main difference between the Dutch TNO and the Japanese institutes is the way they look at innovation. TNO is very self aware about its role in the Netherlands concerning innovation. On the other hand, the Japanese are more looking at a few research fields where they do a lot of research in and the innovation follows from that automatically. The cause of this is, that at the moment innovation is a very hot topic in the Netherlands which leads automatically to a more prominent role of innovation within institutes. In that way it is hard to say whether the Dutch are better in doing innovations.

The strong point of the Japanese is that they can focus very hard on one or a few subjects, leaving the rest apart. Doing that, the Japanese get very good at those subjects and that is when the real innovative products versus techniques arise. This is the case at AIT and RIEC, but can probably also be seen at other research institutes. There is however a negative side of this approach. For instance at AIT, in the research to perpendicular magnetic recording other techniques or products are also discovered. But unfortunately nothing is done with those new techniques or products. If Japanese institutes discover a groundbreaking technology the first thing they almost always do is make sure they get a patent on it. If it is a technology or product which does not fit in the research field of the institute, the patent will usually be sold. It is striking that they seldom start a spin-off company which focuses on this new technology. In the Netherlands this is much more the case.

5.6.9 Conclusion

From the comparison of these institutes some conclusions can be drawn which can, but do not have to necessarily be, overall conclusions for institutes in Japan and the Netherlands.

Japanese institutes focus more on the research items which can have innovative results. In the Netherlands however, the focus is more on innovation and then the research which is needed for this. That can be one of the reasons why in Japan a lot of money is spent on the research facilities, which are not always used to the optimum. In the Netherlands, the focus is also on the available knowledge. Another important thing that confirms this conclusion is the view on patents. In the Netherlands there is more an idea about the strategy on what to do with developments and patents than in Japan.

In short: in the Netherlands the goal is more focused on innovation, in Japan the focus is more on research.

5.7 Division 80: Higher education

by Maarten Bezemer, Eelco Dalhuisen, Laurens van Oostveen, Harald Profijt and Janarthanan Sundaram

In this section observations during visits to Ritsumeikan University, Tohoku University, Akita University, Osaka University and the University of Tokyo are compared with the University of Twente and our conclusions in the preliminary report. At the University of Twente we focused at the following chairs of the faculty of Electrical Engineering: SMI (Systems and Materials for Information storage), MI (Measurement Instruments and techniques) and ICD (Integrated Circuit Design).

In the following subsection the Japanese universities, apart from Tokyo University which is presented in 5.6.5, and Dutch chairs are presented. In the discussion the preliminary conclusions are compared with the conclusions from this report. In the last chapter our main discussion and conclusions are presented.

5.7.1 Dutch universities

When looking at the field of Electrical Engineering, the Netherlands only has three universities which are of interest: the universities of Delft, Eindhoven and of course Twente. There are some differences in reputation at these universities, however educationally the three are pretty equal. Together in 2004, the three universities attracted about 200 new students to join the ranks of the electrical engineers which is, although comparable to last year, quite sad when compared to years before. Note this does not include the numerous students who follow Electrical Engineering at non-university instances [59].

Each university has its own educational program but it is not uncommon for teachers to teach courses at two or maybe all three universities. There is an obvious competition between the universities of wanting to be the best, but this ensures at least cooperation to some degree and similarity in the different programs. The competition itself is about reputation, both student and university, and money. None of the universities are privatized, but they still have to show their worth to the community as well as the government for funding and contracts of every sort.

Being from the University of Twente ourselves we are of course biased and therefore we will examine it more closely.

5.7.2 University of Twente

The University of Twente, situated in the east of the Netherlands, was founded in 1961. The university calls itself "De ondernemende universiteit" which roughly can be translated to "The entrepreneurial university". For the university this means a modern university that links academical expertise to social involvement, the joining of education and research in technical and social science. For the students this means the university actively supports student activities in all sorts, be it sports, organizational, educational or artistic.

The university defines itself by the following aspects: [60]

- Flexible educational system preparing for the future;
- The only campus university in the Netherlands;
- Research contributing to the society and technological innovations;
- A great national and international interest towards society, companies and other universities.

Organization

The university is divided into 5 faculties, being:

- Behavioral Sciences (GW);
- Business, Public Administration and Technology (BBT);
- Electrical Engineering, Mathematics and Computer Science (EEMCS);
- Engineering Technology (CTW);
- Science and Technology (TNW).

These faculties harbor a total of 20 bachelor and 28 master courses. The course of Electrical Engineering belongs to the faculty of EEMCS. The faculty of EEMCS again is divided in 27 "leerstoelen" or chairs, 11 of which are closely tied to EE (although most of them have ties with all 3 educations in the faculty) [61]. In the next subsections, we will look more closely at three of these chairs: SMI, MI and ICD.

Relations and market

The University of Twente is not privatized; its educational system is controlled by the government. Although this ensures that the education level is the same across the country, it does not allow much freedom; at times the hands of organization are tied, follow orders and try to make the best of it.

In 2003 the university received a subsidy of €164 million, which is over 60% of the total cashflow [60]. This subsidy is the major driving force that keeps the university alive, binding the university to the government. It allows focusing more on education and less on making profit to keep the university running. However, this subsidy is still performance based (on e.g. student results and research quality). As a result, education has been more generalized and streamlined to results. From an organizational bird eye this works fine, but some things affect the quality of education (better results can be achieved by better or easier education and unfortunately “easier” is the cheapest, easiest way) and sometimes professors and students wish it were not so.

Within the Netherlands, the university cooperates with other educational organizations, adding to the Dutch knowledge infrastructure, to improve national competition with other countries. This cooperation consists of all sorts of things from developing advanced curricula to exchange projects. The university is member of the European Consortium of Innovative Universities (ECIU), but is not restricted to Europe alone. The university as a whole has little direct relations with companies; this is handled by each faculty (or not rarely: by individual chairs) based on field of interest. Research done is both fundamental, practical or feasibility studies. It is both push and pull, sometimes companies have an interesting idea and other times companies become interested by research being done. Apart from this, there is no direct contact with the market; it is not the primary goal of the research.

TOP is the University’s service setup to support starting companies that want to make use of the knowledge and the facilities of the research groups on the Campus. TOP was founded in 1984 to improve the knowledge transfer between the University and the Twente region. Since then 300 people have made use of the service. TOP doubled the number of starting knowledge companies. This service mostly used to start spin-off companies from the technology researched at the university. According to their website the university has generated 437 companies from 1965 till now, of which 297 companies are still left. On average the university produces 13 companies annually. This gives us a high ranking in Europe., but we shouldn’t forget that the nevertheless among others we chose to investigate “technical innovation” because of the discussion about lack of innovation in the Netherlands. By placing Twente on a high ranking, the rest of the universities in the Netherlands and Europe acknowledge that they fail in creating spin-off out of the technologies researched on their research group. It is in the best interest if we look very sceptically to these figures. We can be proud of the figures, but we can also conclude that just 13 companies is not enough to generate economical growth in the Netherlands.

Whenever something is discovered or researched at the University of Twente itself, it is first judged if it is worth patenting. If so, the intellectual property and patent goes to the research group, which usually is a certain chair. Research results are released, research papers written and published. The university is allowed to use the patent and results internally for its own purposes, but is not allowed to compromise any commercial interests if the research group has any. This could result in a spin-off.

5.7.3 Chair Systems and Materials for Information storage (SMI)

The history of the group starts with the work of Tsjakko Wielinga and Cock Lodder and their work on CoCr for perpendicular recording in 1980. Research in co-evaporation joined the ranks in 1988 and experiments with oblique sputtering until 1993. Research in magneto-optics focused and in 1995 the group demonstrated the first spin-valve transistor. Their attention to materials made the group publish their findings on the structural parameters and parameters of Ba-ferrite films in 1998. At the same time the next spin-valve transistor was produced which operated at room temperature. Production and performance on this was upped in 1999 and improvements kept coming.

Head of office:	Prof. Dr. J.C. Lodder
Number of employees:	40, of which 11 students
Locations:	Hogekamp 6th floor, Campus University of Twente
Main operations:	To provide an educational program in SMI at an academic level, and to study the science of SMI and bring knowledge into practice

Table 5.31: Basic data SMI

Electrical Engineering

The research activities of SMI concentrate on materials, devices and systems for information storage. The aim of the work on media research has been to determine the relation between microstructure, morphology and the (micro)magnetic properties of thin film recording media. The research on perpendicular hard disc recording media based on CoCrX and multilayers has been extended with perpendicular patterned media, which is strongly based on research work on magneto-optic materials, both multilayers as well as Ba-ferrite.

The educational program consists of:

- Basic courses:
  - Electromagnetic field theory;
  - Information storage;
  - Lab on Realisation in Materials (RIM).
- Advanced courses:
  - Materials science;
  - Magnetic recording systems;
  - Materials for information storage;
  - Nanoelectronics.
- Minor Nanotechnology.

Innovation process

On one hand, there is the bottom-up approach, where physics and materials science are the starting point. Through fundamental studies, fabrication technology, design and characterization they aim at the final realization of a working device or component. Research is centered on magnetic media and spin-electronics. The spin-electronics research is a unique balance of exploratory fundamental studies and strategic application oriented work, and involves:

- Development of innovative nanoscale spin-transport devices;
- Experiment and theory of the underlying physics and materials science;
- Nano-fabrication and nano-characterization technology;
- Implementation in data storage systems and components (magnetic sensors, memory, logic).

Funding comes from a variety of sources, such as STW, FOM, MESA$^+$, EU and the KNAW, while there are active collaborations with world-leading industries, as well as with smaller national enterprises. The research is carried out in closely linked projects, in which the interaction between post-docs, Ph.D. and M.Sc. students with backgrounds in physics, electrical engineering and materials science provides a diverse and stimulating environment.

On the other hand, they work on complete information storage systems, which involve media, recording head, positioning, data channel and their interplay. Research is on the well established tape recording system and the novel probe recording system, which is connected to their probe microscopy activities. The general aim of this research is to investigate issues concerning the process of increasing area and volume bit densities of magnetic mass storage.

The work is divided into two mainstreams. One research field concentrates on the study and development of thin-film tape media. Characterization of metal-particle tape media is also of interest. The other starts from physical aspects of the recording process and includes the study and optimization of linear and track densities and write/read recording heads.

5.7.4 Chair Measurement & Instrumentation (MI)

The group was founded in 1969 with the nomination of Dick Bosman as full professor in Measurement Science and Instrumentation. The main mission at that time was education at an academic level and scientific research in acquisition of data. Research areas started out in the field of information display technology, which was soon accompanied by interest in digital image processing. This evolved further towards computer vision which later turned into digital signal processing. Merging with the sensor research, this resulted in the current research program in Measurement Science.

Head of office:	prof. dr. ir. P.P.L. Regtien
Number of employees:	22, of which 11 students
Location:	Hogekamp 8th floor, Campus University of Twente
Main operations:	To provide an educational program in Measurement at an academic level, and to study the Science of Metrology and bring knowledge into practice

Table 5.32: Basic data MI

Electrical Engineering

The research activities are concentrated on the two phases in the information acquisition process: signal acquisition and signal processing. Research projects cover application areas such as mechatronics and robotics, navigation and traffic, security and safety, industrial inspection and tools for disabled people.

The educational program consists of:

- Basic courses:
  - Measurement Instruments;
  - Basic Measurement Science;
  - Various projects.
- Advanced courses:
  - Digital measurement systems;
  - Sensor systems for Mechatronics;
  - Classification, estimation and data analysis;
  - Pattern Classification;
  - Digital Image Processing.
- Minor Imaging.

Innovation process

The research and projects are divided into conceptual research and more practical applications.

Current conceptual activities include:

- Optical measurements:
  - Non-contact detection of wear;
  - Video tracking;

  - 3D edge detection.

- Acoustic measurements:
  - Time-of-Flight measurements;
  - Range imaging.

- Magnetic measurements:
  - Magnetic flux leakage;
  - NQR spectrum analysis;
  - Magnetic non-destructive testing.

Research in applications includes:

- Industrial applications:
  - Coriolis mass flow meter;
  - Battery management systems;
  - Real time measurements.

- Biomedical applications:
  - Systems for Parkinson diagnosis;
  - Navigation system for blind people.

- Educational applications:
  - Training in measurement and metrology.

5.7.5 Chair Integrated Circuit Design (ICD)

ICs are at the heart of recent developments in mobile telecommunications, multimedia and internet, and in numerous other applications. IC design is of large industrial importance, which is even more true for analog circuit design, in which the European electronics industry has a leading position. The group was founded in 1990.

Head of office:	prof. dr. ir. B. Nauta
Number of employees:	23, of which 13 students
Location:	Hogekamp 3th floor, Campus University of Twente
Main operations:	To provide an educational program in Integrated Circuit Design at an academic level, and to research and find solutions for practical problems

Table 5.33: Basic data ICD

Electrical Engineering

The ICD theme has a firm research tradition in basic bipolar and CMOS circuits, and published many papers on transconductors, amplifiers, integrated filters and audio power amplifiers. Due to many contacts and research contracts with industry, and the part-time position of some members in industry, the industrial relevance of the research program and the knowledge transfer is high.

The educational program consists of:

- Compulsory subjects:
  - Electronic Basecircuits;
  - Electronic Functions;
  - Integration project;
  - Embedded Signal Processing.
- Optional subjects:
  - System-on-Chip Design;
  - A/D Converters;
  - Advanced Analog IC-Electronics;
  - Project advanced electronics;
  - Integrated Circuits and Systems.
- Master courses:
  - Microsystems and Microelectronics;
  - Embedded systems.

Innovation process

The ICD-group does research on integrated transceivers in CMOS technology. This includes transmitters and receivers for wireless (GSM, DECT, satellite, etc.) and wireline (subscriber line, cable modems, fiber) communication systems. They develop clever IC design techniques to realize more portable and faster communication systems at a low cost. Current projects are in the field of AD converters, frequency synthesizers, radio frontends, noise reduction and fiber-optic interfaces. Soon the field of microwave components will be explored. These challenges in high-frequency analog and mixed-signal circuit design are addressed in close co-operation with the industry, in order to find fundamental solutions for practical problems.

5.7.6 Japanese universities

Laboratories

When going to a university as a student, you can be sure of two things: you will be educated, and you will be prepared for the future. Mostly you will have to do this yourself, whereas some of it will be provided by the university in two flavours: theoretical and practical assignments. In Japan, student research is organized in labs and, as we have seen on Tohoku University, sometimes they are the only form of education on a campus. So what are these labs, and how do they compare to the Netherlands?

Designing

There are a couple of characteristics of labs which make it hard to find a Dutch equivalent. From the outside, labs are a group of students working on a subject with a guiding professor making it look like a typical assignment, however the reverse is true; it isn't coursework. Of course, participating in a lab is part of your courses, but not every student participates in the same lab during his or her study. So it cannot be compared to the Dutch common practical assignments, but more to the design projects Dutch students receive during the Master phase.

Guidance

Next, there is a subtle difference in the origin of the projects. The set-up in Japan is simple in the way that the guiding professor sets up the subject or lab of his interest and then finds interested students to participate in it. In the Netherlands, this is mostly the same, where a professor (or more precise: a chair) has one or more projects available that students can sign up for. The difference is in the ownership; in Japan the professor participates actively in the project by leading and/or managing (where as mentioned it is questionable if students are involved in that if the traditional pupil-sensei relation is in effect) and even doing research, whereas Dutch professors are there when you need them, but do not actually participate in the project unless there is direct cause to do so.

Chairs

So there is similarity, but still not equality. Maybe when seen from a different perspective: a lab does practical research in a certain field. The Dutch equivalent of that is the chair, like SMI, MI or ICD. But this comparison looks further from the truth: a chair is run by professors who all work in the same field, with students and employees from all grades practicing their research together or separately, as well as providing regular classes and education. Here we see the similarity again, a chair is like a shell covering or oining multiple labs, where professors are not fixed on a project but instead assist others (and perhaps working on a project of their own). The largest difference is also in that same conclusion, as heard from Tokyo University: we have 120 labs so we have 120 professors; every professor has a lab or project. There is no (official) layer between lab and department.

Results

Of course there are many ways to actually run a chair, and many ways to run a lab, and some ways will inevitably be more successful than others. Dutch projects are geared towards specialisation, but from several (though not all) Japanese companies we heard that students "must unlearn what they have learned" and become practically re-educated. Since this happened mostly at the 'older' companies, this is probably the traditional way to look at education, so it can be questioned if labs really teach knowledge or more about teamwork. Maybe the theoretical teachings at university are only to provide some knowledge to work with, just to learn how to work.

5.7.7 Tohoku University

Following Tokyo University (1877) and Kyoto University (1897), Tohoku Imperial University (later renamed to Tohoku University) was founded in 1907 as the third Imperial University. Today, Tohoku University is one of the largest as well as oldest university in Japan, comprising 10 faculties, 15 graduate schools (including 5 graduate schools with no respective faculties), 5 research institutes, and many other educational and research centers and facilities. The facilities are located at five campuses in Sendai.

The university has always had a step ahead on other universities in Japan. An example is the fact that Chicka Kurudo graduated as the first female doctor of Science in Japan at Tohoku University. Also this university was the first to start a forum on gender equality to stimulate women to participate in academic studies.

Through an open door policy, Tohoku University welcomes foreign university employees and students to share knowledge and cooperate in joint research projects. At both research institutes and the university itself, international exchange grows every year. A reason for this fact can be found in the opportunities that are offered to students from both Japan and overseas. "Research-first" and "open-door" policies put strong emphasis on education led by prestigious scholars and researchers.

Some basic data about Tohoku University can be found in table 5.34.

Main relationship with other organizations in Electrical Engineering:

- New Industry Creation Hatchery Center (NICHe): research facility to contribute to the development of new technologies and industries;
- Tohoku University Research Networks (TURNS): research by joint groups from different disciplines;
- Research Institute of Electrical Communication (RIEC).

Number of staff members:	4.948
Number of students:	14.247
Revenue:	¥41,332 million
Expenditure:	¥113,282 million
Location:	University campus in Sendai
Missions:	Globalization, cooperation and competition
University disciplines:	Arts and Literature, Education, Law, Economics, Science, Pharmaceutical Sciences, Engineering, Agriculture, and Schools of Medicine and Dentistry

Table 5.34: Basic data Tohoku University

Electrical Engineering

The university is well known world wide because of its leading edge research in Electrical Engineering. Results nowadays can be found in innovative projects like Aerotrain (a flying train) and achievements in solar or wind energy. Also the fact that the microwave, the antenna and the fist magnetic storage device were invented at Tohoku University gives an indication of its historical achievements.

Innovation process

A nanotechnology & information communication technology (NT & IT) research and educational centre has been founded to form the world-strongest interdisciplinary Centre Of Excellence (COE) in the fields of electrical communication and electronic engineering. One of the important functions of the centre is the “QI School”. The “QI School” is a research and educational program based on the Quadruple I’s: Interdisciplinary, International, and Interchange between Industry and academia to promote active researchers and engineers in NT & IT fields throughout the world.

Industries of semiconductors, magnetic recording and liquid crystals are strategic industries for constructing an advanced IT society of Japan. They face strong challenge from both sides of Europe/America and Asia. It is highly desirable to use the wisdom of universities for keeping a long-term competitive edge in these fields. Tohoku University has long been conducting the world-class original researches in the fields of IT & NT for material and device development. The Department of Electronic Engineering was selected as a former educational research COE due to its great research achievements.

With the Department of Electronic Engineering as a core, an NT & IT research and educational centre has been founded to form the world-strongest interdisciplinary COE in the fields of electrical communication and electronic engineering. Department of Electrical and Communication Engineering, Research Institute of

Electrical Communication (RIEC) and New Industry Creation Hatchery Centre (NICHe) are joining this program. Basic research achievements of material process evaluation etcetera will be utilized for applied research of advanced devices and systems. The original technologies created by this program will strengthen the international competitive power of the country.

The following three research groups have been set up and are cooperating with each other to acquire international leadership in the fields of next generation electronics devices, communications networks and etcetera:

- Fundamental research and analysis/evaluation technology;
- Semiconductor magnetic optical and display devices;
- Computing and transport technology.

In the COE program, the QI school has been established. Practical lectures and seminars by first-class foreign researchers are introduced into the curriculum for the second half of the doctoral course. Worldwide excellent students will be solicited as elite doctoral candidate students in the short term course of the QI school. Also the best students will be selected from the regular courses. They are given 3-ranked research grant.

The QI school will hold periodically the mini international conferences participated by students. First-class researchers will be invited to this conference to give interdisciplinary tutorial lectures. The students will be trained to improve their ability to present and debate in English. Elite doctor students in the short term course will be dispatched for an errantry education to the industries overseas research institutes etcetera under the young researcher training and super internship program of QI school. The QI school is employing postdoctoral researchers to conduct international joint researches in cooperation with first-class researchers. This program is considered as the gateway to become worldwide researchers.

Experiences with students

Shouraizou organized a competition between teams in building a bridge of spaghetti and tiny ropes that should carry two cups of water. Groups consisted of both Dutch students and students from Tohoku University. After the competition, the visit was ended with a diner in a restaurant in Sendai city.

We experienced that there are differences in the way Japanese and Dutch students tackle a case like this one. Dutch students use the brainstorming technique: everybody says of writes down what he of she thinks. Japanese students start thinking very hard, so only smart ideas will be shared with the rest of the group. It takes a little more time, but their ideas are higher quality. Because the Japanese language is phonetic, the students had some difficulties in talking with us in English. We think the Dutch would experiment more to learn the language better and to understand what someone means. The Japanese think very hard before saying something in English and take their time in understanding what someone means. Because of this, the Japanese made a very polite and intelligent impression on us.

5.7.8 Ritsumeikan University (Quantum Beam Science Laboratory)

Ritsumeikan University was established 135 years ago in 1869 as an evening law school for working people. In 1913 the school got its current name Ritsumeikan and in 1922 it got the status of university. Since then it has been growing and now it has 3 campuses in Kyoto, Shiga and Oita, also it has 3 junior high schools and 3 senior high schools in Kyoto and Sapporo. Ritsumeikan's primary goal is to provide students with the opportunity to conduct new scholarly research. In order to reach this goal Ritsumeikan puts strong efforts into introducing new research and educational standards.

This subsection is mostly about the Quantum Beam Science Laboratory (also known as Yamada Laboratory) of the Photonics Department. This laboratory is doing research at x-rays with their newest portable MIRRORCLE synchrotrons. The synchrotrons are called portable because of their small sizes, the MIRRORCLE-6X is even the smallest synchrotron in the world.

Information about the Biwako-Kusatsu Campus (BKC) can be found in table 5.35, the basic data about the Quantum Beam Science Laboratory can be found in table 5.36.

Name:	Biwako-Kusatsu Campus
Year of foundation:	April 1994
Empoyees:	1,300 staffmembers 15,000 students
Revenues/Expendures 2004:	¥98,9 billion (total for Ritsumeikan University)
Location:	Southeast of lake Biwa in Shiga near Kyoto
Main operations:	To intergrate social sciences, natural sciences and education to students
Main relationships:	One of the campuses belonging to Ritsumeikan University

Table 5.35: Basic data Biwako-Kusatsu Campus [67]

Electrical Engineering

The Quantum Beam Science Laboratory has been busy creating a mobile synchrotron in the past years. Nowadays they have 2 working prototypes: the MIRROCLE-6X and the MIRROCLE-20. The MIRROCLE-20 is a 20 MeV syn-

Name:	Quantum Beam Science Laboratory
Year of foundation:	1996
Empoyees:	19 staffmembers 21 students
Revenues/Expendures:	Unknown
Location:	Biwako-Kusatsu Campus
Main operations:	Doing research at and with their MIRRORCLE synchrotrons
Main relationships:	The research is done together with the Photon Producton Laboratory [69]

Table 5.36: Basic data Quantum Beam Science Laboratory [68]

chrotron and the MIRROCLE-6X is a 6 MeV synchrotron specialized at producing high brilliance x-rays. The dimensions of the MIRRORCLE-6X are 2 x 1 x 1.5 m and only 100 kg, this is why it's called a mobile synchrotron.

The x-rays produced by the MIRRORCLE are generated by putting a target into the electron orbit. When the electrons hit the target x-rays emitted, the electrons that didn't hit the target will be kept in the ring and will have a new opportunity, resulting into a high energy transfer rate. Because the electrons are being reused the target can be made very small, since it doesn't matter that the electrons don't always hit the target the first time. The small target results in a very narrow x-ray beam.

The hard x-rays can be used to produce high resolution images of different types of objects like ceramic, metal and soft (human) tissue. The resolution of the images is high because the x-ray beam size is very narrow. The x-rays can also be used for medical (cancer therapy), industrial (sterilization), imaging (x-ray microscopy) or R&D (protein crystallography) purposes.

Innovation process

The MIRROCLE synchrotrons are quite an innovation, since they are the first portable synchrotrons in the world. Now that the prototypes are finished and working, it's possible for companies and institutes to order them. Because of the little space needed it's possible to use them on several locations, so it's possible for different researches to use them for their research. It's also possible for hospitals to use them for imaging and therapy. It's even expected that it will be possible in the future to use the synchrotrons for imaging purposes and treatments at the same time on the patients, but before this can be done more research is needed.

The research which was done in order to develop the MIRRORCLE is patented and can't be used by other institutes or companies to enhance their synchrotrons or to develop other things using the new technologies. Only the Photon Production Laboratory has access to the research results since this company builds the synchrotrons for customers.

Context characteristics

The research needed to build a portable synchrotron could only be done, because the Japanese government supported the Quantum Beam Science Laboratory by giving subsidies. These subsidies had to come from the government because the research topic was created by the Ritsumeikan University and not by an order coming from companies.

Since the synchrotron project was started by the Ritsumeikan University and wasn't ordered by other parties, the MIRROCLE is a market pushed product. It's built first and later, when it's finished, it will be advertised in order to sell it to other companies.

5.7.9 Akita University

Akita University was established in 1949 by fusing Akita Normal School and Akita Mining College. On the first day of April, 2004, all the national universities turned into National University Corporation. Akita University is no exception. The university is no longer directly under the control of the Japanese Ministry of Education, Culture, Sports, Science and Technology.

The university consists of three faculties: the Faculty of Education and Human Studies, the Faculty of Engineering and Resource Science and the School of Medicine [70].

The Akita University provides a wide-range of knowledge as a center of academic research and culture, and conducts specialized research and studies. The Akita university also aims at cultivating people who contribute to the progress of peace and culture, by developing intellectual, moral and application capabilities.

The Venture Business Laboratories (VBL) is built in National Universities in Japan, and aims at bringing up students with both highly professional knowledge and creative venture-mind. The research subject of the laboratory is "Development of the new recycling technique and advanced material design for rare metals" [71]. Researchers of VBL are university staff members and graduate students [75].

The university consists of 3 faculties for research and 3 graduate schools for education. The faculty of Engineering and Resource Science consists of 7 departments, the Mineral Industry Museum, Research Institute of Materials and Resources and education by correspondence Course. The school of Engineering and Resource Science consists of 7 master degree Program departments and 4 Doctor's Degree Program departments.

Basic data of Akita University can be found in table 5.37. The organization of the Akita University is depicted in figure 5.6.

Number of graduate students:	245 [70]
Number of undergraduate students:	951 [70]
Budget (2001):	¥25.193 million [71]
Location:	Akita City, Akita Prefecture

Table 5.37: Basic data Akita University

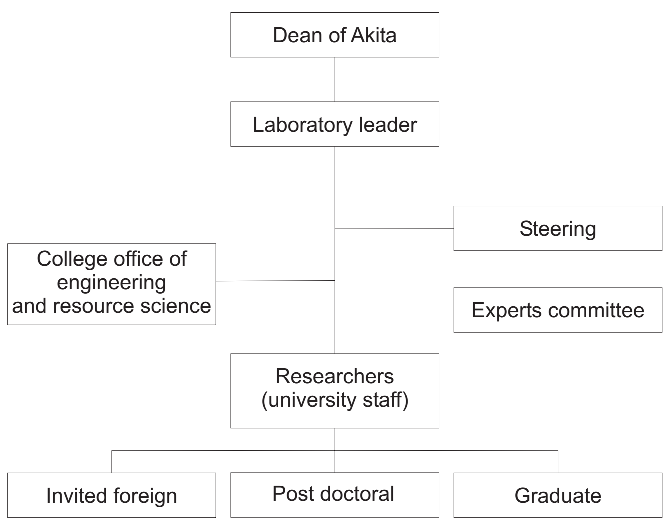

Figure 5.6: The organization of Akita University

Electrical Engineering

The Department of Electrical and Electronic Engineering was established with the aim of nurturing far-sighted talents to be fully competed to meet the present requirements of the highly-technological and information-oriented world. The research and instruction are performed based on four main branches: Electric Energy Engineering, Photonic and Electronic Device Engineering, Intelligent Information Communication Engineering and Control System Engineering. These four cover the principal fields of the present technological world completely. Examples of research projects are High Energy Electro-magnetic Phenomena of Elementary Particles and Method of Measurement, Study on the Optical and Electronic Materials including Semiconductor Thin Films, and Their Application to Optoelectronic Devices, Liquid Crystal Engineering and Application to Optical Devices, Education and research on signal analysis and processing in acoustic wave, and more [72].

The Venture Bussines Laboratory is specialized in material science, which is connected with Electical Engineering. The topics of this laboratory are research and development of new purifying and recycling technology for rare element resources, fundamental and developmental research on highly advanced functional substances containing rare elements, R&D of recycling method for rare elements and the system for resource-recycling circulation and environmental study on rare elements and their recycling [76].

Innovation process

Akita University created the following set of basic guiding principles [70]:

- Promotion of world-class education and research;
- A greater commitment to community service and resolution of global issues;
- Teaching students so they may become able to play an important role globally as well as locally.

This is, according to the president of Akita University, Miura Akira, realized in the form of a set of mid-term, innovation promoting, goals. These are summarized in the next paragraphs [70]:

Education

Akita University wants to establish a student-centered educational system. A greater effort will be made to help students to become capable of contributing to society with a broad range of general knowledge, advanced expertise, and sound ethics. To this end, Center for Promotion of Educational Research and Affairs and the Student Support Center will be established.

Research

Akita University wants to promote various research projects, basic as well as advanced, which are intended to promote a harmonious co-existence with nature. A greater effort will be made to develop a type of technology that is anticipated in real life world. Various cooperative research projects will also be organized. Research will be encouraged also in other areas including humanities, basic sciences, and various seminal research studies. The university has already contributed a great deal in the fields of bioscience and rare metals, but a greater effort will be made to push them to promote our research in these areas to a world-class level. To do so the Center for Bioscience and the Venture Business Laboratory will be established.

Cooperation

Akita University wants to create wider communities, including not only those of local areas, but also other countries. With the help of the Cooperative Research Center, the university will cooperate with various industries and government services. By so doing, an attempt will be made to enhance cooperation with industries, medical services, and education in local areas. In order to facilitate various undertakings in the area of life-long education, the Organization of Social Service will be established, thereby the outcomes of the research being rendered to the society more effectively and efficiently. The university hospital will also be reformed so it may make an even greater contribution to the community.

Akita University wants to establish internationally-based educational and research centers to deal with various global issues. The International Affairs Office will be established to accept a greater number of international students, and to send a greater number of students from Akita University to overseas institutions.

Evaluation

The performance of the university will be evaluated regularly in terms of mid-term goals by means of valid and reliable measures. The Evaluation Center has already been established for this purpose. The Center employs full-time staff, who will help facilitate the administration of the evaluation. The information will be gathered internally (e.g., the teaching staff and students of Akita University) and externally (e.g., general public opinions, and mass media).

It takes a student 2 years to finish his master in the graduate school of Education and the graduate school of Engineering and Resource Science. It takes 4 years to finish his master in the graduate school of Medicine. It takes 2 years longer to become a Doctor of Science. It is not possible for students to participate in courses of other graduate schools, they only participate in courses of their own direction. The professors come from the faculties and give courses in the graduate schools. Students do research in the faculties. This means that education and research are closely connected, so the student learns to become a researcher. Evaluation of the education is done by the evaluation centre, which was founded last year, to improve the education. Students do not participate in this evaluation, but will participate in the near future.

The cooperation between companies and Akita University depends on individual contacts by professors. The intellectual property centre creates contracts between companies and professors. The university works together with a lot of other universities in the world.

Akita University has about 100 foreign students. It has connections with overseas universities.

To promote the research on rare metals to a world-class level, the Akita Venture Bussines Laboratory was established. Professors came with the idea to fund a laboratory for recycling rare metals and to improve the mining industry and the government approved. This is because Japan has a lack of resources and has to be careful with them. Projects in VBL are done by volunteers. The government and the companies do not support the research that is done in the Venture Bussines Laboratory, because the Akita University privatised. The university tries to get support and thinks it will be achieved in the future. Several disciplines collaborate in this laboratory, so graduate students who work on projects for the VBL can collect a broad range of general knowledge in this way. VBL patents new techniques and inventions. Professors can set up new companies with these ideas, but will not receive support from VBL.

Context characteristics

Recycling is a hot item in Japan. Almost every company, institute or university we visited has research projects about recycling. VBL is a good example of this trend.

Experiences with students

We had dinner with nice and friendly Japanese students and employees of the Akita University after the tour at Akita University. Some of us spoke to international students or employees who came to Akita to do master courses or their PhD. They liked Akita University and had enough opportunities to learn about scientific subjects.

5.7.10 Osaka University

The academic origins of Osaka University trace back to Kaitokudo, the Edo-period school for citizens, and Tekijuku, the school of Rangaku (founded in 1838). It is believed that the spirit of the university's humanities faculties stemmed from Kaitokudo, while that of the science faculties, including medicine, came from Tekijuku.

Kaitokudo was founded at Amagasaki, Osaka (now Imabashi, Chuo-ku, Osaka City) in 1724 by citizens. Its liberal atmosphere free from any academic schools or dogmas was welcomed and supported by Osaka merchants and contributed to upgrading the cultural and intellectual levels of Osaka, and it attracted students from all over the country as an academic center in western Japan. Although the school building was burnt down during World War II, books and other literature, about 48,000 items in all, survived the flames and were later presented to Osaka University from the Kaitokudo Commemorating Society. They are collectively stored in the university's library as "Kaitokudo Bunko".

The University of Osaka was inaugurated as an Imperial University in 1931, spanning its 70-year history; Osaka University has conducted education and research with the aim of establishing itself as a world-leading institution contributing to advancement in the level of human knowledge. Osaka University has come to encompass 10 faculties/schools, 14 graduate schools, 5 research institutes and 2 national facilities for Joint Use, in addition to a number of other facilities, in its development as one of Japan's most distinguished universities [77].

Number of staff members:	4.500
Number of students:	20.000
Revenue:	¥46.2 Billion
Expenditure:	¥99.4 Billion
Location:	2 campuses in Osaka: Suita Campus and Toyonaka Campus

Table 5.38: Basic data Osaka University

Main activities

As any university Osaka University's main concerns are education and research. The Japanese research universities follow a CoE (Centre of Excellence) program. This program comes from the government and was started after privatizing all universities. Osaka was a government university and relied solely on government funds. But now it has changed, with the CoE program every university has to promote a key fundamental field of research, wherein the university will do its research. The universities will then be judged on their accomplishments in these fields. The CoE for Osaka University are:

- How Genetic Information is Transformed into Individual Life;
- Hopes for Industrial Innovation Using Superconductivity;
- Top Runner in Immunology Research;
- Super Five Senses-Development of a Brain-like Sensor;
- Hi-tech for Research and Development in the Next Generation;
- Uncovering the Molecular Mechanisms of Incurable Diseases.

To do research in these fields, Osaka University created different institutes:

RIMD

This is one of the most prominent research institutes in Japan, consisting of five divisions and 19 departments specializing in infectious diseases, virology and immunology, cancer and developmental biology, molecular biology and molecular biomedicine. The faculties are not only involved in research, but also engaged in education of the doctoral and master's course students at the Graduate Schools of Medicine, Science, and Pharmaceutical Sciences. Every year, the Institute also trains several researchers from developing countries in cooperation with the Japan International Cooperation Agency (JICA).

ISIR

ISIR was founded in 1939 to conduct research into the basis and applications of natural sciences for industry. The research originally covered a wide range of fields including electronics, information sciences, metals, inorganic chemistry, organic chemistry, biochemistry, polymers and radiation. ISIR has been recognized as one of the elite science and engineering laboratories in Japan.

The Institute consists of six research divisions covering 24 research departments and three joint-use laboratories: the Radiation Laboratory, the Materials Analysis Center, and the Research Center for Intermaterials. Aiming at the creation of new science combining the three domains of materials and devices, information and intelligent systems, and biological and organic molecular sciences, ISIR promotes interdisciplinary and general research to solve problems faced by the next generation of industry, such as energy efficiency, greater use of information, global environmental protection, and an aging society.

ISIR has been selected as a core research (CoE) institute of materials science by the Ministry of Education, Culture, Sports, Science and Technology, and is working on research of global importance with the second research building newly constructed in 2001. In April 2002, the Nano-science and Nanotechnology Centre will also start, substituting for the Radiation Laboratory and the Research Center for Intermaterials. Regarding education, ISIR gives lectures for the Graduate Schools of Science, Engineering, Engineering Science, and Pharmaceutical Science, and trains human resources. An international symposium is held annually to promote international exchanges in academia.

IPR

IPR consists of 11 divisions and one centre, which contributes to scientific research and acts as a core protein research institute in Japan. Since the human genome project identified all of 3 billion base sequences of human genome, it is admitted that analyses of structures and functions of proteins are more important than ever.

ISER

ISER was founded in 1954 as a research institute attached to the Faculty of Economics, and in 1966 became independent of the faculty. It is the only research institute at a Japanese national university that specializes in modern economics. ISER faculty members engage in both theoretical and empirical research on a wide variety of topics ranging from microeconomics, macroeconomics, international finance, and economic dynamics to problems facing Japan such as the recession, the financial crisis, the environment, and an aging society.

JWRI

JWRI is the institute where "joining science" is researched. It is a field that is absolutely essential to manufacturing. Most structures today, in the wide sphere of space from the outer universe to the depths of the sea, are often used under extreme environments where they are exposed to super high/low temperatures and super-high pressures. Obviously, this demands high performance products in the manner of strength, corrosion resistance, abrasion resistance, heat resistance and so on.

Materials are diversified: metals, ceramics, organic materials, and composites. To create structures that can handle these strict environments, our research into joining and welding technology is carried out based on a broad number of areas including material science, mechanics, electrical engineering, physics and chemistry. The Institute has two research centers and three research divisions for Materials Processing System (four departments), Materials Joining Mechanism (three departments) and Functional Assessment (three departments). Research results are announced at conferences and international symposiums both in and outside Japan

Members of JWRI participate in graduate education programs in cooperation with the Graduate School of Engineering [78].

Electrical Engineering

We did not get see the CoE institute during our visit, this is mainly because our field of interest is Electrical Engineering. The institute that best matched this field was the nautical research group. This group was doing experiments with wave generators and submarines.

The wave generator that this group was researching could make any kind of wave with any shape that could be derived to Fourier series. The demonstration was very impressive. The submarines we saw had innovative propulsion. These methods of propulsion where based on creatures in nature like the platypus or the squid.

Also here they managed to astonish the group with their accomplishments.

Innovation process

The initiatives for these projects were from the professors, who started these projects and put students on those projects to do assignments. The initiative didn't come from the board or government.

The projects are not made solely with their own knowledge. The knowledge transfer goes internationally through the international masters. It was also clear that new communication methods like internet contribute to the homogenization of technology, this means that everywhere we have the same standard of technology.

Context characteristics

There was an assumption that the Japanese were very closed in information sharing. We think this assumption was correct for the post internet revolution. Nowadays the Japanese research is more international with a lot of publications worldwide; also the increasing numbers of international students attending universities contribute to this knowledge exchange on a global scale. Although this all seems very similar to the Dutch system, we have to consider the linguistic problems the students have when visiting Japan, and the fact that in the West not many people really promotes Japan.

5.7.11 Discussion

In the preliminary report there were some statements about the education system. One of those statements was that the education level in Japan is lower in comparison to the Dutch education system. Our visit to Japan revealed that the education system in Japan is based on the US system, which means that there is no selection in primary and secondary education. Universities cover the entire range of higher education (MBO, HBO, University, etc). So everyone can apply for admission into Universities. Selection does occur when the students apply for the university, the entry exams at the better universities are harder than the entry exams at the lesser universities. The name that a university has gained is mostly an indication of the level of the university. This is exactly the system that is used in the US.

Statements that the Dutch do more practical assignments than the Japanese are out of place, because of the fact that was explained in the previous part. There are universities which are really into fundamental research and universities which are more practical. We cannot make statements on how much practical experience one gets at a university which belongs to the higher quality universities. But we can say for sure that we have seen enough practical applications at Osaka University.

Japanese students are being re-educated in the companies, as was already pointed out in the preliminary report. In one case a company representative complained about the quality of education in Japan during the study tour.

The professor of a research group in Japan will always get full credit for the research done by his group. This fact is in line with the status that a professor is given by society. It is true that the students will not argue with the professor or show initiative. The last sentence is a result of the first sentence. If the students would show initiative it will automtically mean that they would have to discuss many things with the professor. This is "not done" in Japanese society. Like some of us in the Netherlands will have problems with calling our professors by their first name, the Japanese will never go against their superiors. This is something that is changing gradually, because the Japanese are aware of this problem.

Cooperation between companies and universities is almost not present. The only cooperation that exists is between professors and companies. These professors often share their research with these companies. In the Netherlands the situation is similar; professors in different chairs have direct contact with companies they share research results with. In the Netherlands there is a lot of fuss going around about spin-off companies that are created directly from universities, but we actually question the amount of real spin-off companies. While in Japan the universities admit to have a really small amount of spin-off companies, here in the Netherlands we say undeserved that we are an entrepreneurial university which creates a lot of spin-off. Like in the Netherlands, in Japan there are institutes to encourage spin-off companies, but they are not as successful as here. We say "undeserved", because we as the research group are not aware of a lot of spin-off companies who are really using the university research to produce products. The University of Twente has an institute called TOP that encourages spin-off, last year this institute generated 2 companies, the year before 8 new companies.

When comparing Japanese students to Dutch students, the Japanese certainly do not underperform, maybe even outperform the Dutch. When directly compared Japanese students work harder, which is part of their culture (and, as reasoned, maybe due to teachings of the labs). As we worked with our Japanese counterparts at Tohoku University on the bridge-projects, we noticed it was very easy to dominate over the students as we presented our ideas. Once work got started input came from all sides as on how to proceed, but at times it was hard to tell if everyone actually agreed on what we were doing. Whether this is due to culture, labs, the thought of working with people from the other side of the globe or something else, we can only guess.

5.7.12 Conclusion

The Japanese education model is based on the US education system and therefore the quality of education and research varies with the university. For what we have seen the Japanese education system offers practical application, just like in the Netherlands. Both Japanese and Dutch students have to follow courses intern at companies before they can work there.

The fact that a professor has a very high status is harmful for discussion between students and a professor. As a result students have less initiative.

Cooperation between companies and universities is similar in both countries. In both countries spin-off companies are created but not as much as they may want to. The differences are very small: both countries want to have more spin-offs, and both countries are not really successful in this quest.

5.8 KIVI NIRIA congress 2004: "Market success of innovation strength"

by Frank van der Aa, Michel Franken and Rogier Veenhuis

This section is about the annual congress of the institute KIVI NIRIA in 2004. KIVI NIRIA is The Royal Institution of Engineers in the Netherlands. It is a non-profit institute of engineers that focuses on informative gatherings and activities for its members.

KIVI NIRIA is a learned society, founded in 1847 by and on behalf of professional engineers, and is the oldest on the continent. It is the Dutch professional association *of* and *for* engineers, trained at universities for professional and engineering education, and forms a high quality technical network for knowledge and friends. KIVI NIRIA is a good example of a non-profit organization that supports its members in their innovative activities.

At Thursday October 14th 2004, KIVI NIRIA organized its annual congress at the University of Twente. The subject was "Market success of innovation strength". This day was organised for all members and interested people from businesses to bring innovation in the Netherlands to a higher level. A lot of companies attended the day, gave a lecture or case, or presented themselves with a booth.

All activities on this day are described first. After that the institute KIVI NIRIA is described and at last there are some conclusions about innovation in the Netherlands from the congress.

The visions of some companies and an institute are described below. The first one is the big company Douwe Egberts, by means of a case about Senseo. The second one is the small company Solland Solar Energy BV, by means of a lecture about the large-scale production of solar cells. The last one is the Biomedical Technological Institute (BMTI), by means of an excursion.

5.8.1 Douwe Egberts: Senseo

lecture by Toon Peters (Douwe Egberts)

Since 1978 Douwe Egberts (DE) has been allied to the Sara Lee Corporation, which opened new horizons worldwide. Today Douwe Egberts is the second largest coffee roaster in the world and Philips is one of the world's biggest electronics companies. Together, they brought a brand new concept: the Senseo Coffee Pad System. All aspects of this cup-by-cup concept have been developed by these two companies working together in close cooperation. The Senseo brand is fully endorsed by both Philips and Sara Lee/DE [96].

Sara Lee Corporation is one of the world's leading branded consumer packaged goods companies, selling its products in nearly 200 countries. The company has three global businesses (Food and Beverage, Branded Apparel and Household Products) through which it manufactures and markets products of exceptional quality and value under leading.

A subsidiary of Chicago based Sara Lee Corporation is Sara Lee/DE. Sara Lee/DE is a global group of branded consumer packaged good companies. Activities include coffee, tea, household and body care products. The origin of Douwe Egberts dates back to 1753.

Sara Lee Corporation	
Number of employees:	154,900 persons worldwide
Turnover:	$ 18 billion
Three global businesses	
Food and Beverage (52%):	Meats (Stegeman), Baked cooks (Sara Lee), Coffee & Tea (Douwe Egberts, Pickwick), Duyvis, Lassie, Natureen
Branded Apparel (37%):	Dim, Wonderbra
Household Products (11%):	Sanex, Kiwi, Ambi Pur
Sara Lee/DE	
Number of employees:	Over 26,000 persons worldwide
Headquarter:	Utrecht, the Netherlands

Table 5.39: Basic data Sara Lee

Electrical Engineering

The new Senseo Coffee Pod System from Philips combines a specially developed brewing method with freshly roasted coffee from Douwe Egberts, in convenient portion Senseo coffee pods. Together, they ensure the brewing method extracts the best taste and aroma from the coffee: the perfect cup of coffee.

The reasons for Senseo were that small families often needed one or two cups for and that there were less family moments for bigger families. Also the markets for coffee apparatus, filters and appliances were stable: about 1 million coffee apparatus per year were sold. The market for coffee is slightly decreasing.

The requirements for Senseo were:

- More quality and more variation;
- A full gentle round taste;
- Less time to spend;
- No high pressure, so the cream layer has to be developed by a new manner (patent).

So the concept for Senseo was the importance of the cream layer, for home usage and completely other coffee. It had to be far away from espresso, because it had to be completely new and the market for espresso is very small (2 or 3 percent of the coffee market). The new Senseo Coffee Pad System is perfectly balanced,

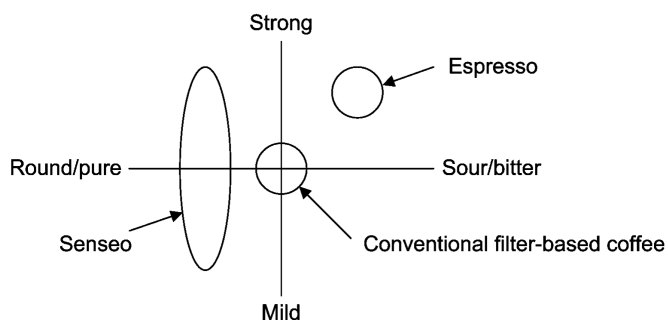

Figure 5.7: Taste of the different types of coffee

always using the same proportions of water and coffee by using Douwe Egberts Senseo Coffee Pads. Thanks to the 1450 Watt boiler, the water is always at the correct temperature and filters quickly and evenly through the coffee. Gentle pressure and a special spray head produce an optimally balanced coffee filtering process. The rich cream layer helps preserve the fine aroma from the Douwe Egberts Senseo coffee pods [96].

Senseo is available in 7 countries. The Netherlands was the first in 2001 (large success). The next countries were Belgium, France and Germany in 2002, Denmark in 2003 and UK/USA in 2004. The amount of coffee and water and the temperature are everywhere the same. So the taste is always the same in these countries around the world. Except France, since the French want less water.

The first research was started in 1996. The first prototype was made in 1997 and 5 years after that (and 20,000-30,000 cups of coffee later) Senseo was on the market. The reason for this long time were the slow years in the beginning. The amount of apparatus that are sold is ten times higher then the expectation. In short time more than four million apparatus were sold. Douwe Egberts and Philips had spent six years researching, developing and perfecting the Senseo Coffee Pod System and specially designed Douwe Egberts Senseo coffee pods [96].

There are also about 100 competitor products (54 brands). Some competitive systems are made in the same factory as Senseo. Other systems are P&G / Black & Decker, Petra Electric&Kraft jacobs, Severin Café 2 and Tassimo Kraft&Braun. The difference with competitors is the publicity of the brand and the quality. It is not possible to protect the pad, but it has the advantage that other pads can be used with the same apparatus. This is one reason for the great success. One year after Senseo, this other pods from competitors were on the market. This "short" time was realized, because of some supermarkets had known it before it was introduced and also other companies had the same production line.

Innovation process

The Senseo is developed by the R&D department, which has 16 years experience, of which 9 years in coffee and tea. The staff is about 100 people and is located in Utrecht, Joure and also in America. SL/DE has a central R&D centre, but with onsite facilities to fine-tune the products on the specific demands of the people in a certain country (America wants bigger cups, France wants smaller cups).

SL & DE are continually looking for cooperation with external partners:

- Increasing integration of total supply chain;
- Increasing concentration in supply chain;
- Increasing cost of production facilities;
- Mature markets go to "cross category innovations", like Mars as an ice cream;
- Changing a market requires high investments.

Because the investments, complexity and risk to do it all yourself are too high. Senseo is a combination of the following four reasons: product facilities, brand / concepts, supply chain access and know-how.

DE has researched and developed the Senseo concept and Philips only the apparatus for DE. It was a completely new system and market, because of the new tastes. Instead of these, the market was asking for a system for a few cups of coffee and new tastes, because the behaviour of people is changed. But SL has put it on the market and they hoped it would be a success. So Senseo is mainly technology push.

5.8.2 Solland Solar Energy: Large-scale production of solar cells

lecture by Gosse Boxhoorn

Solland Solar Energy BV is founded in November 2003 by G. Boxhoorn (director), H. Thijs en J.W. Hendriks. They are ex-staff members of Shell, ABN AMRO and PHILIPS. In total there work 8 employees now.

Solland Solar Energy BV developed solar cells on the basis of a new concept with a higher efficiency (8% dependant of the cell size), lower production costs, more design possibilities and new product offers. The company will build a production line for these cells. The points of interest are: business plan, financing, recruitment of staff, purchasing raw materials and machines, purchasing license, starting sales, engaging architects, contractor, purchasing ground, etcetera.

Solland Solar Energy BV will provide solar cells with high efficiency from the middle of 2005. The first line will have a capacity of 120 MW per year. After 6 months, the second line will be finished with a production of 100 MW per year. The product is not yet on the market, because the financing is not completed. The innovations in the machinery are developed by the Solland team together with machine builders. The company is supported by ECN (has delivered technology for the cells), Econcern (consultancy for renewing energy, one of the biggest ventures in Europe in the field of durable energy) and Tss4U (industrial applications of solar energy systems in oil and gas, telecommunication and cathode protection of pipelines). Moreover Solland also provides consultancy, project management, providing of technology for production of cells and panels. Solland Solar Energy BV has experts in solar energy systems, module development, solar cell development and building instruments. The financing is realized mainly by Econcern.

During the lecture, experiences during the founding a technological innovative company in the Netherlands were discussed especially Very practical subjects came up for discussion, such as location, legal form and financing. But the core subject was the practical lessons from an innovative enterprise in relation with institutes that are stimulating technical entrepreneurship.

What is the relation between the innovation platform and Solland Solar Energy, what are the municipality and province doing, what are the possibilities with informal investors and banks? In short, the value of the intentions and initiatives are weighted from the experiences of the innovation enterprise itself. Gosse Boxhoorn told about some do's and don'ts from his own experience.

Some question markers were placed at subjects as the innovation policy by the government, the support for techno starters (not enough money from government), knowledge transfer and the durable energy policy.

The Netherlands is Europe's number two in concerning installed power. The market of solar cells was about 560 MW in 2002, in 2003 about 750MW and in 2004 is more than 1GW expected. The mean growth is 25%. The potential of solar cells is larger than consumer electronics. Also the turnover of silicon for solar cells is larger than for chips.

The prognosis about energy in the next years is that energy is increasing, the amount of cars is highly increasing, an oil crisis is predicted and so people are looking for alternatives. The government is committing on biomass and wind energy and not for solar energy as an alternative.

Advantages of this project are 25 years guarantee, supply certainty, no maintenance, no emissions, modular applicable and a large public. Disadvantage are the high initial costs. These are realized by subsidies for 70% (30% commercial).

The market is subsidized as to compete with oil, but it is very small in the Netherlands at present. After 2010, the prices for solar cells and oil will be crossing. The competitors are independence solar cell manufacturers (Q-cells, Ersol, Sunpower) and integrated manufacturers.

The technology behind the solar cell is a licence for ECN back side contacting. This means that the upper side is not covered and this causes 8% higher efficiency. Also inline manufacturing is used from CD/DVD technique. The products are a 6 inch standard solar cell, an 8 inch BSC (Back Side Contact) solar cell and an 8 inch "mini" cell.

The project is a new building on the border of Heerlen-Aken (unique) at location Avantis. This building contains a hall for 2 lines and there is an option on ground for 4 halls (10 lines). The financing for this project is partly realized by subsidies. When the minimal investing in the Netherlands is €13.5 million, the subsidy in the Netherlands is €2 million. The subsidy in Germany is €1 million.

The experiences and conclusions from Solland Solar Energy were in short:

- Duration of licences in the Netherlands and Germany are very different;
- Very little amount of risk capital is present in the Netherlands;
- Support from the government is limited till letters from an institute (UWV) and a minister (Zalm);
- There is not much local support;
- Policy for techno starters is absent: too many institutions (innovative or not?); too less money;
- Abolish subsidies; policy is better (e.g. compulsory for a new building);
- Innovation policy: backing the winners; no vision;
- Knowledge transfer: look at Asia;
- Durable energy policy in the Netherlands is dramatic;
- No sun;
- The Dutch government is slow;
- Booming business;
- Industry is much bigger than consumer electronics;
- It is a unique chance for the Netherlands, do not miss it!;
- Many chances on innovation and innovative products;
- Many chances for new companies.

5.8.3 Biomedical Technological Institute (BMTI)

BMTI is the institute of the University of Twente where all research activities in the (bio-) medical field are brought together. BMTI aims at improving the quality of life of human beings, by restoring body performance whenever there is a need to, because of loss of function through diseases, accidents or more age-related deterioration of human functioning. In the multidisciplinary research of BMTI eleven different groups of the University participate by combining their technical expertise with the know-how and day-to-day experiences of (bio-)medical practice. Depending on the problem, BMTI's research may focus on various issues from (early) diagnostics through medical intervention, cure, care and more rehabilitation related activities.

Through a long history of biomedical research in the University of Twente, BMTI is recognized world-wide as a leading institute in this multidisciplinary field of science where engineering concepts and methods are employed to solve and understand medical and biological problems [82].

The points of interest of the institute are R&D, training PSD-students and maintaining connections with companies (hospitals).

The research projects are bio-mimetic engineering, biomechanical and non invasive diagnostics.

Output of the institute:

- 130 scientific;
- 106 publications (for research);
- 10 patents (for companies);
- 16 papers (PhD thesis).

Instead of artificial limbs, artificial and real (from the body) materials are combined. The body is not shedding this material and it has no side-effects. The scope is legs, cartilage (vascular crafts) and blood-vessels (artificial nerve guide). Neural interfacing is implemented by means of nerve cells on chip.

BMTI and the R&D of Roessingh belong to the Centrum for Revalidation Technology (CeRT). The themes of this centre are:

- Attitude, movement and assessment with virtual reality;
- Prosthesis, orthesis;
- Functional electronically stimulation;
- Neuron prostheses;
- Electromyography.

The vision of BMTI is: taking technology to health care, while taking care of our technological disciplines.

Innovation process

The innovation process in the Netherlands is described here by the vision from various people. First the vision on innovation from Rector Magnificus van Vught

(Univerity of Twente) is given, by means of a lecture about science to market-oriented thinking. After that, other visions are described, which were the outcome of a debate about knowledge valorisation.

From science to market-oriented thinking

lecture by Prof. Dr. F.A. van Vught

The University of Twente has been called the entrepreneurial university of the Netherlands for twenty-five years. There are no high barriers between science, product development and market introduction, but just cooperation between the scientist and the market-oriented thinker. In these last years, there are 450 new companies founded at the university. Today the universities give attention to bring the innovative ideas on the market and the competitiveness between the universities in the past is now turned to cooperation. Moreover the government has to put more attention to innovation. The policy of the government has to be focused on more capital for innovation, so that also the Small and Medium-Sized Enterprises (SME) can come with specific questions to the universities. The Netherlands is one of the best in generating new scientific insights. The University of Twente is one of the best in creating spin-offs. These spin-offs convert the know-how to usable applications.

The Netherlands as a country does not innovate enough. It belongs to the lasts of the European economic. The labour production has to increase. The low labour production has the following consequences:

- Too less usage of the present knowledge;
- Too less interaction between companies and knowledge institutions;
- Too small enterprising sense;
- Too little mass and focus in research;
- Too little knowledge workers;
- Too complex intermediary knowledge infrastructure.

In Europe, there is too less effort with respect to the Lisbon ambitions. The European Higher Education Area (EHEA) is starting slow only and the European Research Area (ERA) is even still a discussion.

Culture break is needed to improve the points above:

- Increasing knowledge investments quotient;
- Stimulate admissibility at companies;
- Social innovation is crucial;
- Symbiosis of knowledge and valorisation;

- Reorder of institutional structure. Bring about a direct connection between businesses and knowledge institutions by control bodies.

In the US 2.3% of the gross national product (GNP) is invested in higher education and 1.1% in the EU. Many private investments are carried out in the US.

Some points that have to be changed are:

- A task of the universities has to be the valorisation of the research. The universities have to be assessed for their results, their contribution to the growth of the productivity;
- The obstacles for the foreign knowledge workers have to be deleted;
- The policy for patents has to be improved, such as extending grace period and reducing yearly tax for the patents.

The conclusions about science and innovation in the Netherlands:

- Get out of the ivory towers;
- Economical usefulness is allowed;
- Innovation is teamwork;
- 3TU plan offers large chances;
- Innovation is more than invention;
- Engineers (Masters): indispensable, but not enough.

Knowledge valorisation

discussion by Wim Bens, director Innovation Lab TU Eindhoven; Marco Waas, TU Delft; Pim Breebaart, director Haagsche Hogeschool (university of professional education in The Hague); Meine Oosten, faculty L&R TU Delft; Thomas Grosveld, project manager Innovation platform

In the beginning, the participants were informed about the activities by the universities of professional education and engineering education to transfer the present (or new created) knowledge to other people. With these activities, the institutes create a contribution to the Dutch economy and so arise an extra flow of funds.

Pim Breebaart gave an overview of the activities at the universities of professional education about selling knowledge to the market. The most important issue is not valorisation, but utilisation of the present and acquired knowledge. The aim of the region consultant in The Hague is to improve transmitting of knowledge to the Small and Medium-Sized Enterprises (SME). The costs for the company are kept low symbolically. An implementation of this is "The best idea of the Netherlands" (`http://www.hetbesteideevan.nl`). From 239 entries, 110 are transposed to models and descriptions. Twenty of them are patented, 6 are sold and 9 are commercial interesting. Thus the aim is to generate knowledge and products and let them transfer to the market by the SME.

Wim Bens gave an explanation about the activities on the three technical universities. These are the commercial activities with and around knowledge to get to wisdom, including the started enterprises. The most important role for a university is education. Fundamental research is the second role and the third is stimulating spin-offs by young engineers.

Meine Oosten provided some examples of projects that can start from a faculty and the many pitfalls that are to be dealt with.

Thomas Grosveld gave an introduction on the Dutch report "kennis in versnelling", which is produced by the Innovation platform. The interesting points were:

- Proposals for system interventions;
- Catalyst of new actions;
- Accelerator;
- Culture changer.

Finally, Marco Waas talked about the multiple of knowledge valorisation. Improve knowledge circulation by three-way traffic between the student, the university and the company. SME has no market, but customers. "You ask, we do!"

5.8.4 KIVI NIRIA

The Royal Institution of Engineers in the Netherlands KIVI NIRIA is a learned society, founded in 1847 by and on behalf of professional engineers, and is the oldest on the continent. KIVI NIRIA is the Dutch professional association of and for engineers, trained at universities for professional and engineering education, and forms a high quality technical network for knowledge and friends.

The aim of the association are the representation of the interests of the engineers as occupational group, the promotion of the technique in general and the support for the individual engineer during the career. It promotes the professional, personal and social interests of its members; it is not, however, a trade union. The headquarter is in The Hague.

Membership is open to graduates and students (from first year onwards) of the Dutch Universities of Technology of Delft, Eindhoven and Twente, the Agricultural University of Wageningen, the technical faculties of the University of Groningen and to all graduates and students of the faculties/institutes of technology and agriculture from the universities of professional education (HBO). The universities of engineering education in the Netherlands entail 5 years study and the education of the universities of professional education entails 4 years study.

Currently KIVI NIRIA has more than 28,000 members, including 1,500 students. KIVI NIRIA has only one grade of membership - 'member' - and there is no professional title, as is the case for the corporate membership grades of the professional engineering institutions in the UK and some other countries, for example.

Organization

The members of the Representative Council (60) and of the Executive Board (12), of which four are members of the Daily Management Committee of that Board, are chosen from and by the members of KIVI NIRIA. This is for a period of three years, with the possibility of continuation for three years more. The Executive Board and the Daily Management Committee (6 members) are chaired by the President. The basis and the heart of the Institution are its 34 Divisions, which are active in a lot of disciplinary fields.

In addition to these specialized Divisions and an energetic Junior Division, which has 4,000 young members including students. There are seven regional Departments. The Divisions and Departments organize approximately 300 events annually, such as seminars, symposia, excursions, conferences, lectures and courses on various technical and technology related subjects.

The Institution publishes a fortnightly magazine "De Ingenieur", which was founded in 1887 and has a current circulation of 35,000 and about 150,000 readers. In addition, members can also subscribe to various professional journals at attractive reduced rates. Furthermore, the Institution publishes a variety of reports, brochures and suchlike on technical and technology related subjects and issues regulations and directives for professional practice. Some publications are in English.

KIVI NIRIA is a good example of a non-profit organization that supports the transfer of knowledge in Dutch society. This is accomplished by organizing symposia, excursions, congresses and distributing a scientific magazine. With the social gatherings it also expands the scientific networks of its members. It supports its members in their innovative activities.

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International contacts

KIVI NIRIA is a member of FEANI (European Federation of National Engineering Associations) and of CLAIU (Liaison Committee of the Associations of University Graduate Engineers of the European Union).

Agreements of cooperation

Apart from these memberships, the Institution has agreements of cooperation with a number of engineering institutions and societies. For example, in the UK with the Institution of Civil Engineers (ICE) and the Institution of Mechanical Engineers (IMechE) and in the US with the American Society of Mechanical Engineers (ASME) and the American Society of Civil Engineers (ASCE).

Most divisions take part in international conferences in their field of science or technology in cooperation with their counterparts. Some Divisions are members of European and/or international federations active in the same disciplinary field, such as the Convention of National Societies of Electrical Engineers of Western Europe (EUREL), the European Federation of Chemical Engineers (EFChE) and the International Federation of Automatic Control (IFAC).

They may also act as an observer in organizations such as the European Committee of Civil Engineers (ECCE) [89].

5.8.5 Discussion

In this part, the observations during the annual congress of KIVI NIRIA will be compared with the preliminary report.

In the innovation study it was mentioned that it is often believed and not uncommonly true that the disruptive and radical innovations usually originate from relatively small firms competing in the innovation chain, whereas the emergence and incremental innovations are dominated by the larger, probably international, firms. There were too few companies present at the congress to say much about it, but it was notable that the opposite is not excluded, since Douwe Egberts has made a disruptive innovation and Solland is working on an incremental innovation.

In the macro study a lot was said about R&D. In comparison to Japan the Netherlands invest less in R&D. This is a big competitive disadvantage. The shares of exports that are technologically intensive are about one third for both, but Japan invests more into research and development than the Netherlands does. This was confirmed by the lecture about the large-scale production of solar cells. In the Netherlands is very little amount of risk capital present. One of the reasons for this is the recession.

Since the latest recession, Japan has shifted more and more towards open trade and investment like the Netherlands. The Netherlands is trying to reduce the regulations, giving companies more space to innovate. This is contradicted by Solland. They mentioned that the Dutch government is slow, because it costs a lot of time to get licences. In Germany is it much faster. There is no policy for techno starters in the Netherlands: too many institutions that had to check if it is innovative or not. Moreover a lot of rules are connected on subsidies.

Also in the meso study something was mentioned about changing policies. The governments and companies believe that innovations are a strong and long term solution to make the economy healthier. In order to achieve these innovations, a government sometimes has to make some offers. Fighting your way through regulations takes an incredible amount of work if you want settle in the Netherlands. This was also mentioned by Van Vught and Boxhoorn. They say that governments have to change policies. They have to reduce the amount of rules and institutions for new innovative companies. Also more support and finance makes it easier to innovate, e.g. improving the policy for patents, such as extending grace period and reducing yearly tax for the patents.

Innovation is teamwork. There is too less interaction between companies and knowledge institutions. One of the solutions is improving knowledge circulation by three-way traffic between the student, the university and the company.

5.8.6 Conclusion

At the annual symposium of KIVI NIRIA there was a lot of focus on the innovation climate in the Netherlands. The Netherlands is one of the best in Europe in generating new scientific insights, but the problem lies in the development of innovative products with those insights. Although successes like the Senseo, occur, too few innovative products are developed and put on the market in the Netherlands. The government, universities and the companies are now working together in deploying various initiatives to improve this situation.

The Dutch engineers look towards Asia, especially Japan and China. They are examples how to handle with innovation, because the Japanese economy was growing very fast after World War II and the Chinese economy is now growing very fast. But the Asian people look towards the Western countries, because they are not enthusiastic about their own innovation and think that we were better in understanding innovation.

Some points of interest, which were mentioned a lot of times, are that risk capital for R&D should be increased, the number of regulations decreased, policies should be changed and people should be working together more. So there is a lot of work to do.

There is a lot of debate in the Netherlands on the issue of technical innovation. On the annual congress of the KIVI NIRIA institute several high-ranked members of the technical society in the Netherlands gave their vision on how companies and the government should deal with innovation. The most important aspect is that innovation needs to be more than doing research. Commercial products need to be developed from that research in order to make an innovation successful and the role of the government should be to support this process. This was also demonstrated with an overview on the development and introduction of the Senseo. Sara Lee saw the opportunity, sought cooperation with an important partner and together they introduced something brand new.

5.9 Conclusion

by Michel van Dijk

This section will try to answer the main research question concerning the micro-level research:

> *What factors support or inhibit "technological innovation" on the organizations' level?*

First of all it has to be noticed that it turned out to be a lot more difficult than expected to make a comparison between Japanese and Dutch CIUs. This can already be seen in the conclusions for each division. It appeared to be very hard or sometimes even impossible to compare companies even if they belong to the same division. Companies, institutes and universities naturally are different and cannot always be compared one-on-one. It is therefore also not possible to generalize a Japanese CIU and a Dutch CIU and claim striking contrasts. The differences between the CIUs themselves is larger than the difference resulting from the nationalities.

Besides the problem mentioned above, there is another problem that makes it hard to draw reliable conclusions. The visits to a CIU typically take a few hours up to half a day. This amount of time is generally enough to get a broad view of a company, but it is of course impossible to collect all ins and outs in such a relative small amount of time. Therefore a lot of general information is available, but detailed information could not always be gathered.

To deal with these problems no conclusions will be drawn that claim what a Japanese CIU and what a Dutch CIU looks like. This image cannot be generalized. Instead, the most remarkable and notable differences that have been noticed will be summarized.

Organization

From the preliminary research it was noticed that in Japanese companies there is a lot more hierarchy compared to the Dutch flat "poldermodel". During the excursions it was indeed seen that this is the case, but somewhat lesser than expected. Japan is, as one of the participants nicely put it, *more shifted towards a Western attitude than we had expected*. Despite this shift of attitude, Japanese culture still has a very large influence on company culture.

In general one could say that the Japanese are very formal, compared to the Dutch, for whom informality is common in most companies. The Japanese seem to be more regulated than the Dutch. In Japan, one accepts the situation without discussion, while in the Netherlands people are more outspoken and will bring up any kind of disagreement. This can also be seen in daily Japanese life. No one will ever discuss in public, while in the Netherlands everybody will express his opinion.

In an organization this means that the Japanese generally will follow the request of their superior without any (or much) discussion. We will not claim that this is a bad or to the contrary a good situation, and it is also not clear if this has a positive influence on the results of a company and innovation.

Government

It was noticed that in many places, the Japanese government has a relatively large influence on innovation. A lot of research projects are funded by government, both in universities and research institutes. This is for example the case at SPring-8 and The Earth Simulator Center. Also research institutes are started as an initiative of government, as was the case with the Akita Institute of Technology. Following this strategy, the government tries to stimulate innovation and research and development.

In the Netherlands, the government also has the policy to stimulate innovation, but this is organized in a different way. The government tries to create a climate in which it is beneficial for companies and institutes to innovate. It seems that the influence of the Dutch government is less direct and also smaller than in Japan. In the Netherlands there are also many research projects that are funded with government money, but slightly less than is the case in Japan.

Cooperation

In the Netherlands cooperation between different companies is quite common. Also cooperation between universities and companies takes place at a large scale. It was expected that in Japan companies were more working by theirselves, but it turned out that also in Japan cooperation is common.

Large companies work together on developing large techniques. When questions were asked about this, most of the time the response was that indeed cooperation took place. Also it was presented in such a way that such cooperation naturally took place. From this it can be concluded that cooperation between companies is quite common in both Netherlands and Japan.

Attitude towards innovation

In the Netherlands innovation is a hot topic nowadays. The government is stimulating innovation by all means, and there are discussions about innovation all around. In Japan, the term innovation seemed to be less common. Japanese do not worry about innovation, they do research and from this innovation follow naturally. This contradicts to the Netherlands, innovation is wanted and therefore research is done. This seems a push-pull difference between Japan and the Netherlands.

Reflection preliminary conclusions

In the preliminary report the following conclusions considering culture were drawn. Relevant cultural aspects:

- The enthusiasm to grasp opportunities. Regarding this it can be said that the Japanese strongly believe they are better. This creates a culture that makes the Japanese implement the best of the others and that enhances their ability to improve them. The productivity of Japanese employees is a little higher than that of Dutch employees. Although the Dutch employees are a little more effective, they cannot compensate for the working time of Japanese. This difference is getting larger in favour of the Japanese.
- The level of appropriation of technology developments. In our research, it appeared that Japanese people show a great curiosity to new ideas. Japanese consumers are early adopters of innovations, while the Dutch belong to the early majority.
- The quality of communication lines between persons over which technology is transferred. In Japanese enterprises, a strong formal as well as informal structure go hand-in-hand. In the Netherlands, there is no such two-way communication line. The Dutch formal structure becomes more informal by time.

These aspects have all been noticed during our visits to the Japanese CIUs. They were not always clearly visible, but in general these aspects do apply.

We cannot claim that there is more attention paid to or a better climate for innovation in either Japan or the Netherlands. But it can be clearly seen that indeed there are significant differences between these two countries.

Chapter 6

Conclusion and recommendations

by Niek Bouman

6.1 Final conclusion

In this section, a conclusion is presented about the entire research project. In this conclusion, it is tried to answer the main research question, which is repeated here:

> *What are the key factors that influence technical innovation in Japan and the Netherlands?*

First of all, we would like to state that conducting this kind of research is a complex task. Making a comparison between Japan and the Netherlands with Dutch students is not entirely objective; the students are biased. Besides, differences of scale between Japan and the Netherlands sometimes make a comparison more difficult. On the other hand, an advantage of comparing Japan to our homeland is that the Netherlands is a good reference for the participants. They have a good feeling for the Dutch situation and therefore it can be easier to place Japanese facts and figures in the right perspective. Nevertheless, information gathered on the internet can be wrong or outdated. An excursion just gives a single impression of the organization. How reliable is such an impression? How strongly does it depend on chance? During visits, the host could be an engineer, whereas the questions asked are about managing innovation. Despite of all these difficulties, a couple of strong conclusions can be drawn from the outcomes of the research parts. Finally, we would like to mention that this conclusion may contain some elements that we have noticed during the study tour, but are not explicitly mentioned in the innovation study or the macro, meso or micro research parts.

Prejudices

Firstly, Japan is more western-like than expected. Some decades ago, the general Dutch (stereotypic) view of Japan depicted the Japanese as disciplined cost-efficient mass-producers of products of which the embedded technology was copied from Western countries, and sometimes slightly improved. This view has been out-of-date for a long time, though. For instance, nowadays there is little difference between the organizational structures of Japanese and Dutch companies. However, we noticed that a lot of the old prejudices still exist. An example of such a prejudice is: "Japan only focusses on applied research", whereas in practice both basic and applied research is conducted at large scale.

Cultural factors

A key factor that strongly influences technical innovation in Japan is the unique cultural characteristic of the Japanese people. Being Japanese is something special, such pride is not found in the Dutch society. This pride strongly supports their competitiveness. The Japanese are curious to new technology, which creates a beneficial domestic market for (Japanese) companies that want to sell their new innovations. In terms of the innovation study, it can be said that the Japanese are early adopters of innovations, whereas the Dutch belong to the early majority.

Japanese society is rather closed. Although most of the official international trading barriers (import duties) have been abolished, it is still difficult for foreign companies to get access to the Japanese market because of cultural barriers. Besides being closed, the Japanese society is very hierarchic compared to the Dutch society. The bottom-up approach of innovation (e.g. an employee that takes the initiative and presents a new idea to the management), which is not uncommon in the Netherlands, encounters problems while being introduced in Japanese organizations. Japanese people find it difficult to express themselves freely to somebody with a higher status, because of the risk of insulting that person. We have also observed such reservation among Japanese students talking to their professors. There are even Japanese companies (for instance Toshiba) that have special programs to make their employees more expressive, in order to enable bottom-up processes. In short, the Japanese are aware of this problem and work on solutions. So, the Netherlands appears to have an advantage with respect to the assertiveness of its workers. Although, according to a Dutch company, communication in Dutch companies can be too informal which can slow down the process of decision-making, and in the end innovation.

The gap between Japanese and Western management structures becomes smaller. On the one hand, some Japanese management concepts have become famous worldwide and have been adopted by non-Japanese companies (like "Kaizen"). On the other hand, the rock-hard international competition forces Japanese companies to drop some of their Confucian management approaches (e.g. the policy not to fire people), and to, for instance, put more effort into making profit instead.

Economic factors

Economically, both countries are currently facing a stagnating economy. For a matter of fact, these problems have been going on for a longer period in Japan (often entitled as "the lost decade"). Both economies have shown signs of improvement, but it is not clear if these recent growths will continue. Another economical similarity is the fact that both countries shift their focus towards China because of its strong growth and market potential.

Governmental factors

The Japanese local (prefectural) governments together with the national MEXT ministry have a relatively large influence on innovation. In size, these Japanese local governments should be compared to the entire Dutch government. A lot of research projects are funded by these governments, both in universities and research institutes. We have seen some signs of competition between these local governments. As an example, we were told that SPring-8 was built to exceed the neighboring government's synchrotron. Anyway, the Japanese local governments try to stimulate innovation and research and development. In the Netherlands, the government also has the policy to stimulate innovation, but this is organized in a different way. The government tries to create a climate in which is beneficial for companies and institutes to innovate. It seems that the influence of the Dutch government is less direct and also smaller than in Japan.

Higher education

With respect to universities, the Japanese system is similar to that of the United States. The term "university" in Japan is given to all higher education institutions. In the Netherlands, the higher education system is divided into different levels, and only the schools belonging to the highest level are named "university".

An interesting additional remark is the fact that a recent change in the Japanese education funding system has resulted in a stronger competition between universities, and therefore impedes cooperation.

Research

In both countries, the universities are mainly conducting basic research. Cooperation between companies and universities takes place in Japan as well as in the Netherlands, but we do not consider it as an obvious stimulating factor for innovation.

Universities as well as big companies do sometimes create spin-offs. For universities, it is just a tool for commercializing knowledge. For companies there can be other reasons, like a misfit between research output and the company's core business or, according to Philips Research, to decouple research and development from the fluctuating economy and to protect it against the impatient (short-term visioned) shareholders. According to the *"innovation paradox"*, the Dutch are not very successful in valorizing knowledge. Mainly because of this observation, there has been a strong focus on innovation recently in the Netherlands.

6.2 Recommendations

This section consists of some recommendations about the research project. We distinguish three types of recommendations: fundamental remarks that concern the set-up of the entire research project, but also additional things that would have been done when there would be more time available. Thirdly, we have some minor remarks about things that should have had just a little more attention.

In the micro research part, differences of scale between some companies complicated the comparisons. It would have been possible to divide the companies according to another classification than the United Nations' ISIC. An example would be a classification based upon the Electrical Engineering masters, offered by our university. Another approach is to partition the set of organizations by looking at figures such as the number of employees or turnover.

Besides, to make an indisputable comparison of an industrial sector between two countries, a huge amount of companies belonging to this sector are needed. In a study project like Shouraizou, the number of organizations that can be visited is limited, of course. Therefore it remains difficult to make comparisons in the micro research part. There is a trade-off between the broadness of and depth of the comparison.

With respect to education, it would have been interesting if we had included the Dutch HBO (higher vocational education) in our investigation. This would make the comparison between the Japanese and Dutch higher education more fair.

Finally, we heard several prejudices about Japan during the research project. It would have been interesting to make a list of prejudices prior to the study tour, in order to check their correctness during the tour in a more structured way.

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PART II

OTHER ACTIVITIES

Chapter 7

Study tour

In this chapter, the most important part of the Shouraizou project will be described: the tour through Japan. First a short introduction will be given by a rough overview and the itinerary. After this, the tour will be described by daily reports made by a group of participants during the tour. These reports describe the experiences and the extraordinary feeling of being on a study tour.

The tour schedule reflects three equally important aspects of a study tour: research, culture and fun. Often there is a clear distinction between these aspects, but some special activities combined these three aspects naturally. The example of the perfect mix between research, contemporary culture and fun must be the spaghetti bridge building contest and the dinner afterwards with Japanese students in Sendai.

Although the Shouraizou committee has arranged the tour almost completely by itself, this would not have been possible without the extensive help of others. For example, Japanese contacts of our professors were the key in the arrangement of the excursions and Japanese languaged help has been invaluable in the arrangement of accomodations.

These people, Japanese and Dutch, in Japan and in the Netherlands, have become close friends of Shouraizou. For their help the committee cannot thank them enough. Because of this, the study tour could be molded around Shouraizou's ideas with almost no limitations. This has made the Shouraizou study tour like every other study tour: the perfect one.

7.1 Schedule

The travel schedule is shown in table 7.1 and it is drawn in a map of Japan in figure 7.1.

		City	Activity
Mon 1 Nov		Amsterdam	Travel: Departure from Schiphol Airport
Tue 2 Nov	PM	Osaka	Travel: Arrival at Osaka Itami Airport
Wed 3 Nov		Osaka	*National holiday*
			Culture: Aquarium and Umeda Sky Building
Thu 4 Nov	AM	Shiga	Visit: Ritsumeikan University
	PM	Kyoto	Visit: Horiba Ltd.
Fri 5 Nov	AM	Aioi	Visit: SPring-8
	PM	Himeji	Culture: Himeji kasteel
Sat 6 Nov		Hiroshima	Culture: A-bomb dome and Peace Park
Sun 7 Nov		Kyoto	Culture: Kiyumizu-dera and Nijou-jou
Mon 8 Nov	AM	Osaka	Visit: Matsushita
	PM		Visit: Osaka University
Tue 9 Nov	AM	Osaka	Visit: Mitsubishi R&D
	PM	Nara	Culture: Nara
Wed 10 Nov	AM	Shigi-san	Culture: Shigi-san temple
			Travel: Shinkansen to Tokyo
Thu 11 Nov	AM	Yokohama	Visit: Hitachi PERL
	PM	Kawasaki	Visit: Toshiba
Fri 12 Nov	AM	Tokyo	Visit: OITDA
	PM		Visit: Tokyo University
			Visit: Dutch Embassy
Sat 13 Nov		Tokyo	*Day off*
Sun 14 Nov		Nikko	Culture: Nikko
Mon 15 Nov	AM	Atsugi	Visit: NTT Labs
	PM		Visit: Showa Shell
Tue 16 Nov	AM	Atsugi	Visit: Asahi Kasei Microsystems
	PM	Yokohama	Culture: Chinatown
Wed 17 Nov	AM	Tokyo	Visit: The Earth Simulation Center
	PM		Visit: Sony Media World
Thu 18 Nov			Travel: Shinkansen to Sendai
Fri 19 Nov	AM	Sendai	Visit: Tohoku University
	PM		Visit: Tohoku University - student problem solve
Sat 20 Nov		Kinkasan	Culture: Kinkasan island
Sun 21 Nov			Travel: Shinkansen to Akita
Mon 22 Nov	AM	Akita	Visit: Akita University
	PM		Visit: Akita Institute of Technology
Tue 23 Nov		Akita	*National holiday*
			Travel: Shinkansen to Tokyo
Wed 24 Nov		Tokyo	Travel: Departure from Narita International Airport
		Amsterdam	Travel: Arrival at Schiphol Airport

Table 7.1: The travel schedule

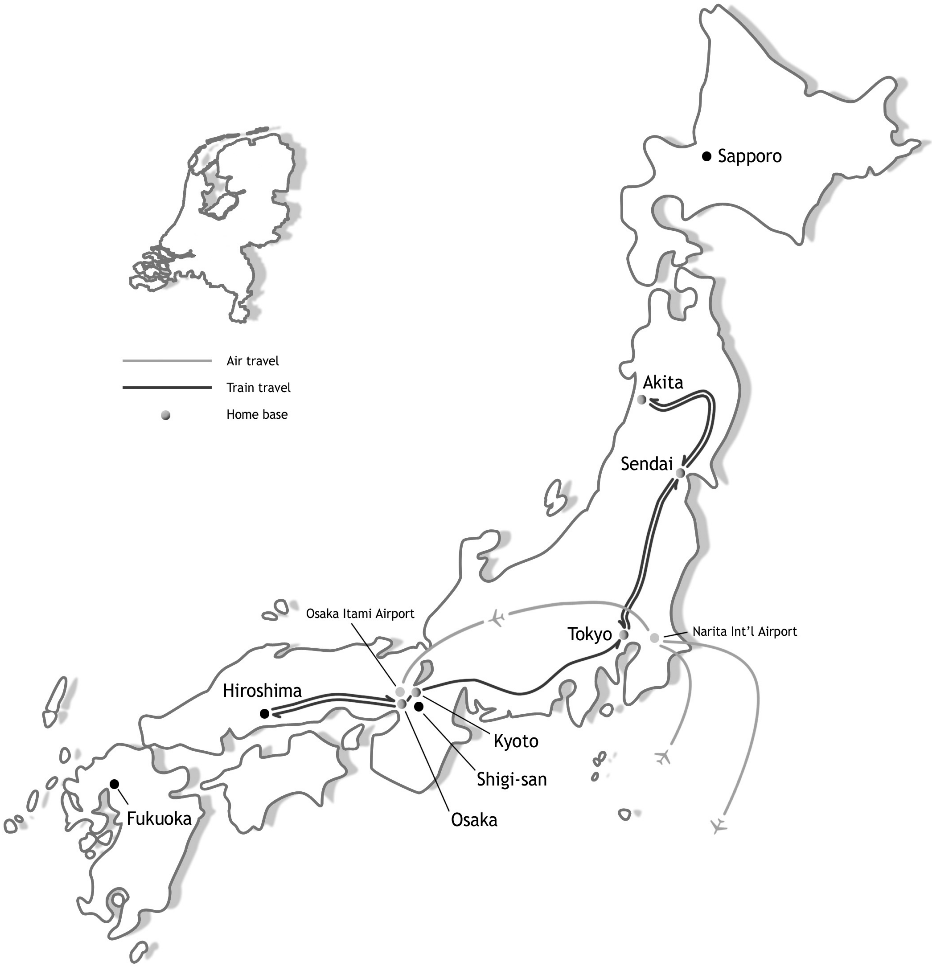


Figure 7.1: The travel map (Japan and the Netherlands are on the same scale)

Yokohama Landmark Tower

7.2 Daily reports

I'm sure nobody has trouble falling asleep. After being on study tour for almost a week, fatigue is beginning to strike its first victims. Half-awake during breakfast, I am thinking about last night.

...Sunday evening, 7 November 23[21]. Like most participants, I have about five hours of sleep each night on average. In order to be able to get up early, I have decided to buy my breakfast for tomorrow at the 24-hours convenience store next to the hotel: tasty-looking croissant-like small breads and a strawberry yoghurt dessert. Buying the strawberry yoghurt is daring, because most of the fruitlike tastes in desserts and drinks in Japan are quite a bit different from those in the Netherlands. I still haven't found out which ones are more like the 'real' tastes and less chemical-tasting. But, being a Dutchman, I definitely prefer the Dutch tastes. So, fingers crossed, because I don't trust those croissant-like breads either...

After finishing the breakfast of the not-so-tasty-after-all croissants and the nice and surprisingly Dutch-tasting strawberry dessert, I manage to move the group towards the bus and we are off to Matsushita!

— *Johan*

During the study tour a lot of participants have kept a diary for themselves like the one above, but there's also a group of participants that kept a diary for all, for the world outside. Their writings have been published on the Shouraizou website, so people back home in the Netherlands could follow the tour through Japan. They were a huge success; a lot of people eagerly read Shouraizou's news from the land of the rising sun and some were so curious about our experiences that they regularly complained that reports of some days past had not been published yet.

Unfortunately, these reports were in Dutch and a lot of Shouraizou's friends could not read about the experiences of Shouraizou on the road in Japan. For this final report, the daily reports have been revised and translated into English. They have been combined in this section together with some photographs. By reading these daily reports, we hope the reader will be able to catch a glimpse of what it is like to be on study tour, an unforgettable adventure for all.

7.2.1 Monday 1st November

by Jasper Klewer

Land of the rising sun! The flight, the cultural differences, the jetlag and the experiences, everything is yet unimaginable, but will prove to be overwhelming. What will the study tour offer us? What surprises will we face? Will we be able to read, understand and speak Japanese? What will we learn about innovation in Japanese companies during our visits?

After months of preparation, or even more than a year of preparation by the able folks of the Shouraizou committee, today the adventure will start towards the land of the rising sun. The start of this tremendous project consists of the bus trip going from our home base for the last couple of years, the Electrical Engineering building, to the other side of the Netherlands: Schiphol Airport.

The objective of our study tour is to understand technical innovation at Japanese companies and institutes. A seven head committee will go to extraordinary length to give the twenty-seven participants the opportunity for three weeks to give all their attention to this cause. One crucial aspect however is the sole responsibility of the participant: the luggage.

One twenty kilo suitcase and ten kilos of hand luggage. A suitable suit, plenty of shirts with matching ties (the Japanese are fashionable!), proper shoes, underwear to last a week (the Japanese are hygienic!), a travel alarm clock, digital camera and CD-Rs (the Japanese also photograph everything when they are abroad!), a clothes line, credit card and passport, truly everything must be stashed in a small rectangular space to be transported to Japan. Everything but swimming trunks, because the Japanese bath naked.

It is not easy to adhere to the twenty kilo rule. Not because of the weight, but because of the fact that no respectable student owns a scale, since we do not want to be confronted with the result of years of study. By study I mean eating too much deep fried food. After a lengthy search among friends and neighbors someone appears to still have a dusty old scale, padded with orange carpet from the seventies. After some adjustments the suitcase weighs nineteen kilogram, exactly enough to be able to surprise the folks at home with a bottle of sake on my way back.

The bus arrives at half past one and the anticipation rises. This is the moment to conduct the buddy check for the first time, the waterproof system to detect missing participants. Every person has two buddies and the group only leaves when everyone has accounted for both their buddies. We are complete! The bus door swings open and one by one we leave the soil of Enschede. Under our feet the suitcases rest, but rest is nowhere to find when chauffeur Arjan makes way to the West.

If the atmosphere in the bus is an indication of the ambiance of the next twenty-three days, this will be the best study tour ever. The lunches that go around vary from English licorice to cherry bonbons and from cake to 'kilo of variety candy'; a solid base for an eleven-hour flight.

Even the face of bus driver Arjan shows an amicable smile, but this soon changes when songs are started by certain extravert Electrical Engineers. Although every song has his roots in the renowned Cantus book of study association Scintilla, the vocals turn the smile of the Rotterdammer into a frown. Thankfully this doesn't change the mood of the others and after four o' clock we arrive at Terminal 3 of Schiphol Airport. We are now ready to start our journey.

Suitcase & bag

We are complete!

Way to the West

Ready to start

7.2.2 Tuesday 2nd November

by Harald Profijt

At Schiphol Airport a surprise waits for Erik in the form of a giant pink flag saying "Staijen-san tanoshii tabi-o" (translated: Mister Staijen, have a good time!). A few hours later it becomes clear that Erik isn't the only one to depart from Holland, some 36 persons are to! At 20^{15} (Dutch time) the moment is there, the plane takes off with destination Narita Airport in Tokyo. It is the beginning of a travel that will take about 11 hours, followed by another flight to Osaka.

For many of us the flight is a huge happening, because it is the first time they fly and have to entertain themselves for 11 hours. It isn't really easy to sleep, but that isn't a problem, because for entertainment we have our own jester Rogier. Already from this beginning, contact and integration with the Japanese travelers is at a good level. They are very interested in the purpose of our travel and they even warn for earth quakes! The idea is very weird...

The chairs in the plane are all equipped with a display and a remote control, to enable us to play chess, reverse and 'boter, kaas en eieren'. It is also possible to watch a movie and to enjoy Japanese music. Nevertheless, most people choose for the option to watch flight information and statistics. There even is a digital map available, accompanied with information about the location, height (>10 km), horizontal speed (about 1000 km/h) and outside temperature (< -50 degrees centigrade).

Because it will be a long flight, the stewardesses serve diner. Despite comparisons with our canteen's food, I have to say it is very doable. In style of our destination, we eat rice, salmon, shrimps, carrots and salad. Off course we use chopsticks in the process of transporting the food to our mouths. Early in the morning (nobody knows what country is having breakfast at this very moment), croissants with jelly are served along with a plate of eggs, bacon, mushrooms, fruit salad and a cup off coffee.

At 15^{40}, 2nd November we land very softly (and without having experienced any turbulence) at Narita Airport. While waiting for our next flight to depart, the organization enjoys their first experience with angry Japanese people and the way they express the fact that they are mad. To be able to travel through Japan, we will need rail passes, so Erik and Johan are to get 37 of them. Because they want so many, the ticket shop has to close and all personnel work on their order. Because Japanese customers have to wait, they are getting a bit nervous, and start shouting things like "I am mad!" and "I want to speak the manager!". Despite this first weird experience with the Japanese, we will have to come back later to collect all cards...

Our flight to Osaka only takes about half an hour, but now most people start to fall asleep. In contrast to our first landing, the arrival at Osaka airport is a bit rougher. It feels like both wings touch the ground, break off and make the cabin spin a few times before crashing into the ground. Fortunately, in reality there is no damage. Well, no damage... The jokes by Rogier reach a new depth!

Our hotel is named "Hoteru Kinki" (translated: Hotel Kinki), a fact that gives us a bit of hope for a wild week. It is situated in the centre of the city's night life. Because most students are very tired, bedrooms are explored after a short walk in the neighborhood. Inside the hotel, both two and three person's rooms are available. There is also a difference in style: Japanese style means having to sleep only on a mattress, Western style means sleeping in comfortable beds. But we are in Japan! Of course we are not to complain about the comfort of our rooms...

Our Japanese Airlines plane

Plenty of space & entertainment

Flight information & statistics

Osaka's night life

7.2.3 Wednesday 3rd November

by Sebastiaan van Loon

Our first day in Japan! Today is a national holiday, the day of Culture, but we don't have a day off. First we will visit an aquarium and then go to the Umeda Sky Building. But before we do, we have to get breakfast in a small restaurant near the hotel. It looks a bit like a snack bar, only there is a smell of fish. There are several ticket machines at the entrance where Johan pays for all the breakfast tickets. We get the tickets and have to give them to the waitress. In return we get a typical breakfast which consists of a fried egg, two pieces of bacon, some raw vegetables, a bowl of white rice, a bowl with salty soup garnished with seaweed and a piece of tofu. There is also bitter cold tea and mineral water. A nice heavy meal; let the day begin!

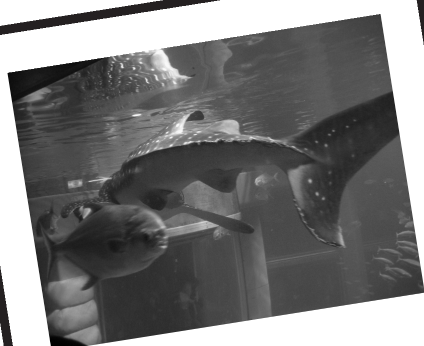
We begin our day with a walk to Umeda station. Here we take the subway to Osakado where the Osaka aquarium Kaiyukan is located. A Japanese lady will show us around today, her name is Mamiko. Now that we see the Japanese world in daylight, we are glad that Mamiko is willing to help us around so we can get used to all the signs and customs. All around us are Japanese people, Japanese signs and Japanese characters. It all seems to fit, but the small things make it feel very strange. For example, if you walk on the street and you want to avoid someone, what do you do? Normally you would go to the right. But in Japan people walk and drive on the left, so before you know you bump into every Japanese person you meet. The Japanese people observe us as some kind of rare creatures. But that is not so strange if you think of it; how often do the inhabitants of Osaka meet 36 tall Dutchmen who have their digital camera within arms reach to record every event. We look like a couple of Japanese tourists!

But OK, in spite of this the committee maneuvers the whole group to Osakado station without losing anyone. Before us a big building arises which contains 13.5 million liters of water. According to the "Capitool" traveler guide this aquarium is an innovative and daring design in which 35,000 sea animals swim. This fits perfectly in with our journey, since our main theme of the study tour is innovation. The main attraction of the Osaka Aquarium is the one and shark whale that is living in captivity in the world. This enormous animal is placed in a huge central aquarium besides other big fish. Around this aquarium there are other aquaria which are divided into several layers and are also divided into several regions of the "ring of fire" (the Pacific Ocean). There is a compartment with at the top otters, another with dolphins and one with seals. The building consists of 14 levels which gives a feeling that you are slowly descending into the sea until the bottom. Everybody is free to walk around through the building and can try their new digital cameras to photograph all different fishes. We probably photographed half of all the fish!

Around 13^{00} we meet each other before the innovative building and return to Osaka station. Here we have some lunch and get our Japanese Rail pass (JR pass) that we need tomorrow. After lunch we walk in the direction of the Umeda

Sky Building, with on the roof the Floating Garden Observatory. This building consists of two towers which are joined at the top. With the elevator made of glass we accelerate to the 39th floor. With an escalator we reach the Floating Garden, which is between and on top of the two towers. This observatory is 150 meter above the ground and has an amazing view of Osaka. It is known for its magnificent sunsets, but it is too cloudy when we arrive to see it. Still we have a fantastic view and we take a lot of pictures from different angles. Of course this is a great place to take a group photo, so we ask a random person to take a picture, and guess what? It's a Dutchman. You meet them everywhere!

The evening program today is free. Everybody gets ¥2000 (€14.80) and is allowed to do what he or she wants. Bert, Bayan, Michel F., Jos, Matthijs K. and I are going to eat in a Japanese snack bar (the same kind as the breakfast place). Even for a beer we have to get a ticket from the ticket machine. It is all very cheap, for ¥1500 we all are full and satisfied. We have some money left and with this money we decide to finish the evening with a ride in the big red Ferris wheel that is located on the 17th floor of a big building. The view of Osaka by night is beautiful; everywhere there are neon billboards and people that walk around. In short: a successful but heavy day, we are all worn-out by it.



Shark whale in aquarium

Umeda Sky Building observatory

7.2.4 Thursday 4th November

by Bertjan Davelaar

Is your tie straight? Shoes clean? Well, time for breakfast! In suit, because today is our first day with official excursions. It's very early in the morning, the alarm-clock went off at 6^{00}... After a typical Japanese breakfast with rise, soup, and egg, we walk to the train station with two students. They will escort us to the Ritsumeikan University, near Kyoto. In the train we can see many nice things: the mountains, the special infrastructural systems, and the special way the electricity network is built... Everything is so different from the Netherlands!

In the train we also get to know the Japanese students a little better. They can speak English very well. The experience so far, is that the average Japanese person speaks English just as well, as a Dutchman speaks Japanese... The students tell us why the streets are so clean, because we are surprised about that. They say that every Japanese will pick up trash if they see it and dump it in a trashcan. Today is a lot busier than yesterday. Yesterday was a national holiday and presumably a lot of people had a day off.

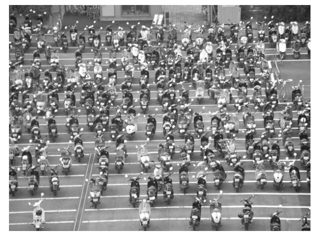
After the train trip and a short ride on the bus, we reach Ritsumeikan University. In Japan many people drive a scooter and at the university we see a huge parking place with blinking mirrors of nice, ugly, rusty and modern scooters. There is even a man who directs the scooters to the right parking spot. In Japan there are many men who have jobs that in the Netherlands don't exist, anyway. They have a light, broom or megaphone and they just do the job they are supposed to do. At Ritsumeikan University we learn al the ins and outs of the smallest synchrotron unit in the world. The presentation is interesting and it's nice to see that almost every Japanese has problems to distinguish an 'l' and an 'r'.

We get a really good lunch, European style. I would say it is a welcome alternative to all the rice. After lunch a coach is awaiting which brings us to Horiba Ltd. downtown Kyoto. We get a funny welcome in Dutch, there is good translator and the people are very friendly, so this visit is really a success. At Horiba measurement and analysis systems are developed, for example for the automotive and medical industry. At Horiba they can determine the exact composition of materials of a coin within 20 seconds. A little culture shock occurs to me, when the coffee is served. This coffee is treated like Coca-Cola. They put ice in it'In the Netherlands we don't have ice cold coffee. I still prefer the hot coffee.

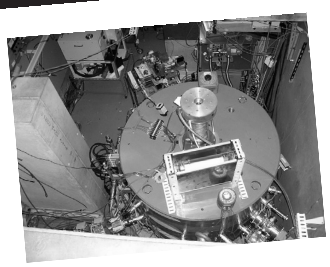
After this coffee experience, we drive with the bus through Kyoto to a temple. This temple is built in characteristic Japanese style. It is nice to see it and it delivers great pictures. It is also the background for our second group picture. In the park around the temple, we walk a little and we find the restaurant where we have dinner. In a big pan we have to prepare the food ourselves. It is very relaxing to sit on the ground and to rest from a long day, so this is a good experience. This is also the place where we say goodbye to the two Japanese students and Takayama-san. He is the professor at the university we visited and he escorted us from there. After dinner we go into Kyoto and around 21^{00} we go home by train.

At half past 10 we're back in the hotel. Some go out for a drink, others go to bed. It was a long and instructive day which also brought great pleasure!

Our first train travel



Scooters



Synchrotron at Ritsumeikan

Horiba tour

Where's my chair?

7.2.5 Friday 5th November

by Roland Meijerink

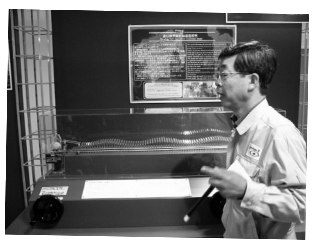
"Rourando, I've got a problem. I can't open my eyes." This Friday starts with these encouraging words from my roommate. We have had some tiring days and the fatigue is clearly noticeable for all participants. Fortunately, breakfast is a familiar ritual: soup, rice, egg, ham, vegetables and corn. For some reason the tofu and seaweed are not present today. Too bad. I really like the Japanese food so far! Paul, one of the participants, said it this way: "I will miss the Japanese food when we get back home, it is really good." Fatigue also strikes me, by the way: today I try to slide automatic doors open manually several times and stay frozen for seconds before non-automatic doors.

Today's program contains a technical excursion to SPring-8 and a cultural afternoon at a castle in Himeji. Our journey begins with a ride on the ever clean, comfortable and most of all very accurate Japanese train. It strikes me that all personnel is very kind: if you show you Japan Rail Pass (the Japanese equivalent of a "OV-kaart" for tourists), you get a kind nod and a small "thank you", while in The Netherlands, you would have to settle with less. It is also remarkable that the announcer that has some information for travelers (no delay!) just stands on the platform, just in between the orderly formed lines of people, perpendicular to the track. That is because in Japan the train is not only very accurate in time, but also in location: doors open and close just in front of you, if you are positioned on the designated spots. We continue our travel with the super fast Shinkansen train: we have to wait a few moments, because the train will change driving direction and the seats have to be turned around! A rented bus (with a driver that wears white gloves, just like all of his colleagues) brings us to our final destination.

Final destination is SPring-8: the largest synchrotron facility in the world. Synchro-what? Synchrotron! To produce very powerful and coherent x-ray radiation, electron are accelerated and stored in a ring. By bending the electrons in this ring, they start to produce x-ray radiation, which is guided through a beam line and is used at the end of this line for various kinds of research. In this way researches can do observations and measurements on a very small scale, or as we were told during the introduction lecture: "We can see the world in a new way!" This kind of company pay-offs are very common in Japan, by the way. Today I am mostly impressed not by the astonishing research results, but by some simple, but very effective do-it-yourself models to explain phenomena like the acceleration of particles or standing and traveling electromagnetic waves. Absolutely brilliant and their creator has every right to be very proud!

After buying a decent lunch at the local supermarket in Himeji (which also sells Dutch 'stroopwafels') and eating it at a parking lot (which is said to be considered strange by Japanese people, but we have no opportunity!) we go to Himeji Castle. The castle and its surrounding gardens are beautiful and I also wonder about some remarkable side-effect. First of all, we have the reaction of 40 cute Japanese schoolgirls, dressed in a uniform with high stockings and small skirt, to a group of 36 gigantic Dutchmen in suit. We call it the screaming-schoolgirls-phenomenon and it is catalyzed by saying a simple "Konnichiwa". We are often photographed as abnormalities or, as somebody stated in a very striking way: "I feel like a desired object." Secondly, I still can't get used to putting off my shoes when entering for example the castle. I have to put them in a plastic bag, while I try to fit in mules that look nice, but are certainly not big enough.

After sweeping the tired but satisfied participants together, we make a group photo, buy ourselves an ice-cream and check whether everybody is there with our unsurpassed buddy check system. We travel home with the Shinkansen 'bullet' train. This time we are lucky to travel with a relatively new model and we have made reservations, so we can all sit down and enjoy a very comfortable journey. Imagine this: the amount of leg space for a two-seater is comparable to that of a four-seater in the Netherlands! Because everybody is so tired, I decide with the committee to skip the evening visit to the flashy neon district Doutombori. I don't regret it very much right now, to be honest. Because I'm too tired to even find me a restaurant, my dinner consists of a few Dutch 'pepernoten' and a bottle of Coke. Now I can take some rest and I will be well rested for a day I have been looking forward to: Hiroshima!



Do-it-yourself models

Himeji Castle

Konnchiwa!

7.2.6 Saturday 6th November

by Michel Franken

Today a cultural visit to the city of Hiroshima is planned. As all of you probably know Hiroshima was the first city to endure the horrors of a nuclear attack.

The breakfast is nutritious as always and soon after we leave for the train station. We travel to Hiroshima by Shinkansen and the bullet train brings us there in a little over two hours. Many of us are still amazed by the astonishing speed with which these trains move. We are traveling with the latest model of JR Central. During the voyage everybody finds a useful purpose for their time: either writing, sleeping or communicating with Japanese people.

In Hiroshima we take the tram to the Peace Memorial Park. In this park you can find the remains of one of the few buildings that was left after the detonation of the atomic bomb. This building is the last building in Hiroshima from that period and serves as a reminder to the world what the consequences of a nuclear war are. The committee has brought sheets of origami and passes them along, so that everybody can fold a bird of crane at the Children's Peace Memorial. This tradition was started by one of the child victims of the bombing that died of leukemia. The people that know how to fold a crane assist the ones that do not know and soon everybody had successfully folded their crane. After this we visit the rest of the monuments in the Memorial Park.

When the morning program is finished, it is time for lunch. We try to locate an "Okonomiyaki" restaurant. Okonomiyaki is a very popular dish in Hiroshima. Along the way we ask several Japanese people for directions and with their help we eventually arrive at the restaurant. In this department building, eight floors high, several Okonomiyaki restaurants are located, at least four on each floor to be precise. The dish served is a combination of some sort of pancake with cabbages, bacon, eggs and sauce. It is delicious! Later it is discovered that the Lonely Planet ranks this spot as one of the top three places in Japan to enjoy an Okonomiyaki meal.

Now that the lunch has replenished our energy, we go back to the Peace Memorial Park to visit the Peace Memorial Museum. The first part of the exposition in this museum shows what preceded the dropping of the bomb, the second part deals with the aftermath and the final part of the exposition deals with the current situation on nuclear testing and weapons. The things that many find the most impressive are the two models of Hiroshima. The first shows Hiroshima as it was and the second showed what remained. Also impressive are the 588 letters from the various mayors of Hiroshima to object to nuclear tests. Whenever a nuclear test is announced by a country, that country receives a letter of objection from the mayor of Hiroshima.

We spend our final three hours in Hiroshima on dinner and sightseeing. The group splits up in smaller groups and these go their separate ways. Some spend most of their time in one of the "Pachinko palaces", while others decide to get acquainted with the local street culture, or apply the "O-makase shimasu"-principle (translated: You decide for us) in their restaurant.

When we are all present at the gathering point we start our voyage back to Osaka. By use of the Shinkansen, the regular train and good old-fashioned walking we get back to Hotel Kinki after a day of many impressions.

Peace Memorial Park

Folding a crane

Okonomiyaki

Model of Hiroshima

7.2.7 Sunday 7th November

by Harald Profijt

A Dutch Sunday usually is a relaxed day at which the streets are empty and people take a walk in the park. In Japan, according to our experiences, it's a little bit different. The 24 hour economy is alive and the streets are as crowded as usual. Also cultural sights are well visited by uniformed school youth, even in weekends. This is based on my own experiences, because this Sunday is a culture day for us as well!

Yesterday, the committee decided we do not have to eat the soup, tofu, rice and salad as breakfast together every day. Nice plan! Early in the morning some of us buy breakfast with the money the committee provided us with. Our choice: sandwiches, chocolate cookies, cold pieces of pizza and a hot unit of (canned) coffee. Yummy! At about 8^{30} it's time to take a walk in the direction of Osaka station to take a trip to Kyoto by train and bus.

As we walk to Kyoto, the road begins to rise and it takes several steps around the corner to get to know why. We are walking on a mountain, with a large Buddhist temple (the Kiyomizu-dera) situated on its top. After a few minutes, we meet the first geishas and buddhistic monks, who seem to enjoy being photographed by Dutch students. At the top of the mountain we get to oppurtunity to take a walk around the temple and to enjoy the scenery.

After the promenade, we prepare for the the second cultural event of the day. By bus, we travel to a castle (Nijou-ji) from the ages of the samurai and shogun. Before taking the next walk, we buy some food at a super market. At the castle we take a look in an enormous Japanese garden. At the top of the mountain it's situated we see both traditional Japan and the modern skyline of the city of Kyoto.

Because we are in world-famous Kyoto, we take the opportunity to visit the city centre itself. After a visit to the famous fast food restaurant "Makudonarudo", we take a look at Kyoto station; an absurd high building with a lot to see that has nothing to do with traveling by train. It's a giant shopping centre and already at 7th November, the Christmas atmosphere is complete with trees, reindeer and music! The hall of the building has a height of more than a hundred meters, very impressive! But, after this visit the day isn't over yet.

Because we skipped our trip to Doutombori a few days earlier because we were too tired, the committee decided to give it a second chance today. Doutombori is a district situated in Osaka that obeys the modern variant on Darwin's law: "survival of the flashiest." After a trip with the metro we see with our own eyes what the deal is: every 50 meters a game hall, every square meter filled with neon. After a few video games, we take a short walk in the streets to enjoy the circus.

As if we aren't tired enough, a surprise waits for us at the metro station. The committee bought us tickets at Kyoto station which are, unfortunately, not valid for our trip back to the hotel. So, another problem appears: how to explain a few screaming Metro employees that you're sorry and would like to solve the problem? When the siren and the employees are calmed down, Johan does a good try in communicating and solving the situation. It works, the metro employees allow us in the metro and everything is taken care of. At our destination, we get escorted to the exit and we depart to our hotel. Perhaps the "Nederlandse Spoorwegen" should pay a visit to Japan for some brainstorm weekends about service... Back at the hotel everybody is tired, goes to bed and dreams about the geishas we met earlier today.

Geishas

Kiyumizu-dera

Doutombori

Survival of the flashiest

7.2.8 Monday 8th November

by Johan Engelen

Today we are going to Matsushita (a.k.a. Panasonic and National) and the University of Osaka (Department of Naval Architecture & Ocean Engineering, Graduate School of Engineering). It will be an easy day for the travel coordinator, because a chartered bus will take us to all places.

We arrive at Matsushita ahead of schedule, so we have more than enough time to take pictures of the statue of Anton Philips. Matsushita has built a fountain in front of the R&D building with surrounding statues of famous innovative people such as Thomas Edison, Michael Faraday, André-Marie Ampère and also Anton Philips. By the way, Anton Philips is the only one without a scientific device in his hands: he is holding a cigar...

Inside we first are given a tour through Matsushita's Hall of Science and Technology. This is a museum with the latest achievements of Matsushita. A sneak preview: an air-co that raises the oxygen level in the air (of course, you can switch it on with your mobile phone) and a refrigerator with a photo-camera inside. That is, really *inside* the refrigerator! You can receive the picture on your mobile phone, so you know what to buy when you are in a supermarket. For example, now you know if you still have enough eggs, provided that you did not hide them from the camera behind the leftovers from yesterday's dinner... There is also a smart console with a large touch screen so an elder person can contact the GP from his or her own house (video and audio!).

Almost every device supports SD-memory cards. Luckily, Rogier has an SD-memory card in his photo-camera, so we can try to view the pictures on a television. With the risk of a terrible picture appearing on screen and bringing the excursion to an abrupt end, Rogier hands over the SD-card. Fortunately it turns out okay: a picture of Bertjan appears on the television. Bertjan having a beer in the airplane, clearly the image of a study tour... After the tour through the museum, we can ask questions to several people from Matsushita Corporate R&D Center. After the Q&A session, we board the bus to depart for the University of Osaka.

On arrival at the university's campus the bus driver has to find the correct building. From the Japanese words of the bus driver, I think we can get off the bus. But, a minute later, it turns out I misunderstood and we have to board the bus again. Nonetheless, 30 seconds later we can get off at the same spot! We follow professor Hasegawa and we leave our baggage in a classroom and go to the canteen for lunch. In the canteen there is a typical Japanese vending machine: put money in, push the button with the picture of the food you like, and a ticket comes out (which you should take to the counter to get your food). But in this case, there aren't pictures on the buttons but only Japanese characters! Luckily we are aided by Japanese students.

First we will get demonstrations of three projects of professor Hasegawa's group:

AMOEBA, PLATYPUS and a robot with two large fins on the side that can be actuated in a wave-like motion, like a squid. AMOEBA is an arbitrary wave generator and sits in a tank. It can generate all kinds of waves to test new ship designs. They are even able to generate a wave with an S-pattern in the water after five seconds! The PLATYPUS is a robot made to simulate the locomotion of a water animal. It looks like a torpedo with fins like a fish. There is a big 'towingtub' in which small ship models can be tested by pulling them through the water. After the demonstrations by the Japanese, it is time for Roland to give our presentation. It's the first time he gives this presentation, but is goes very well.

After two other presentations by Japanese students we are going to barbecue with the Japanese people of Hasegawa's group (including students). It's a bit difficult to handle the meat with sticks. Because it is dark, we burn some of the meat, but there is also sushi and alcohol! It is a perfect party. Because it is our last evening in Osaka, it is kind of special. Because tomorrow evening is at a temple, it's also the last chance for us to go out with Cees Slump and Leon Abelmann in Japan. Professor Hasegawa takes us to a Japanese pub near a metro station. On entering the pub we hear "Goedenavond!" from the back. There is a Dutchman in the pub! It's actually one of the very few Dutch people we will meet during our study tour, so it's quite special. After some time and a lot of drinks, we sing a tribute to André Hazes, but who were those Dutch guys dancing on the table? At the end, professor Hasegawa, Cees Slump and Leon Abelmann share the bill for our party. Thanks! どうもありがとうございます!

A Japanese student helps us with obtaining a student group discount for the metro and I am introduced into the bureaucratic miseries of Japan (for the second time, after the adventure at Narita Airport with the rail passes). With loads of paperwork, stamps and too much questions, we finally obtain our tickets with a 20% discount. On arrival at the hotel, everybody makes their own plans: some go for a last walk in Osaka, others line up behind the PC to use internet and others give up hope for using internet and have a tasty beer together with Cees and Leon.

Squid-like robot

Anton Philips

7.2.9 Tuesday 9th November

by Sebastiaan van Loon

Today we are on the road again, but this time we will not come back to our beloved Hotel Kinki, that was getting so familiar to us. With the free internet, telephone on the rooms and a supermarket next door. The suitcases are being well packed and hopefully all the shirts will not wrinkle too much. Our baggage will be transported with a van to Tokyo, where we will arrive tomorrow. This is because tonight we will sleep in a Temple in Oji. But first we will visit Mitsubishi and after that the oldest capital of Japan, Nara, for a cultural excursion. At half past nine everybody is at the lobby and all in suits. The suitcases are blocking most of the lobby and we are waiting until the van arrives. But the van does not arrive. After three quarters of an hour the committee decides not to wait for the van and to depart to Mitsubishi with the rented bus. The employees of the hotel will look after our baggage and will see to it that it will be loaded into the van.

Because of the delay we arrive three quarter of an hour to late at the company. Therefore it is decided that we will not visit the new escalator. This escalator slows down at the beginning and accelerates in the middle part. But fortunately there is more on the program. First we get a fast introduction of the morning program and then we are divided into two groups. Group two first visits the clean room where X-rays are being used to make smaller chips in silicium. We already saw the device that makes the X-rays in a small version at Ritsumeikan University and a big one at SPring-8. Here at Mitsubishi they have one that has a medium size. The nice part here is that we have to put off our shoes and put on slippers while walking in between the machines. This gives an amusing view, all the students in suits with far too small slippers. Unfortunately we aren't allowed to make pictures of it! After the lab tour the group is guided to the gadget showroom, where all the new products of Mitsubishi are shown. A new graphical card with feed forward which gives moving pictures a sharper view on flat screens, a sort of little screen which you could put in front of your eye so you can watch television or movies, a warmth sensor in a camera and so on. Next the group is reunited with group one and guided back into a room. Here we get two presentations about MEMS (Micro Electro Mechanical Systems) that they make themselves and about elevators they sell. Regrettably all the presentations are hastily finished because of the lack of time and the question hour is changed to a question minute. At half past one we are already in the bus on our way to Nara.

Nara was founded in 710 and became the capital of Japan and one of the most beautiful cities in Asia. Because of the Buddhism the city is full of wooden temples and a fantastic park with tame deer (Shika), which are seen as messengers of the gods. At half past two we arrive at the park and we get money and the opportunity to visit the park and temples until five o'clock. But first it is time to have lunch. Everybody wanders around the park searching for culture and food. After the lunch most of us are going to the Todai-ji temple. This temple consists of a main hall of the Great Buddha (Daibutsuden). This 16 meter high Buddha is one of the things everybody wants to see. The moment you enter the hall is indescribable (though I will try). After entering over the big threshold and get used to the darkness, you will see an enormous statue that peacefully looks down on you. Everywhere there is a smell of incense and candles are burning. Next to the Buddha statue there are two golden Bosatsus from 1709. On the right back side of the hall there is a big wooden pillar with a hole. It is said that if you can crawl through the hole you will reach the nirvana. That is why there is a big line of school children that are waiting for their turn to climb through. Also from our group some people manage to crawl through the small hole! Who knows whether they will reach the nirvana...

Besides this temple several groups go to different places in the park. Some groups walk through the whole park, while others visit another temple or museum. With my group I visit the Kofuku-ji temple with a five story high pagoda from 1426 and a treasure chamber which contains a 6 meter high Cannon with thousand arms.

After this beautiful park it's time to visit our Buddhist temple in Oji where we will spend the night. After a two hour drive, we arrive at the temple in the dark. A monk is waiting for us to guide us to the temple in the mountains. The twisting path that leads upwards is lighted by lanterns every two meters. Everywhere besides the path are small temples. In the dark the place has a mystical atmosphere. In the temple we have to take off our shoes before we walk on the tatami mats (made from rice). In the bedrooms there are also tatami mats and we have to sleep on them. There are also two bathrooms with furo tubs. These are a kind of bathtubs with hot water, where several people can bath in. But first we have to eat before we can try it. The food is also served in a room with tatami mats. The food is liked by most of the people, although some dislike it. After the diner we make an evening stroll to the top of the mountain, where we have a nice view over two different cities. It is a good ending of our busy day.

Todai-ji temple at Nara

Dinner is being served

7.2.10 Wednesday 10th November

by Jasper Klewer

5^{15} AM. Ohayo gozaimasu! Darkness still surrounds us when we awake in the temple. The paper walls stop no sounds, so at least ten alarm clocks can be heard. Sleeping in a temple is a special experience and while we are getting dressed the sun rises above the Japanese garden that lies in between the sleeping chambers.

The morning ceremony starts at six. The thirty of us just fit into the small room that is decorated with a range of ornaments, statues, sacrifices and a large drum. Three monks are sitting in the center, we crouch around them. With loud clapping and drumming the ceremony is opened and to complete the atmosphere clouds of incense rise. The priests murmur together. What they say is incomprehensible, but it sounds impressive. The head monk starts a fire in the center of the room and one by one wooden sticks are being burned. On the sticks wishes are put that are sent to the realm of the gods in this way. For just ¥500 you can send such a wish.

The murmuring gets more ecstatic and the drumming increases. It seems like we are getting drowsed, but we don't know if that is because of the ceremony or the fact that the chamber is full of smoke that came from the burned wishing sticks. When the wood is transformed to the intangible message and the tangible ash the ritual ends. The head priest gives us all a personal blessing. We sure need that with the busy schedule and of six hours of sleep on average.

Yesterday evening the hill near the temple was climbed in the dark; one thousand steps in winding paths. The same path in the mourning is different, fresher, serene. The climb is designed in such a way that when you think you are almost on the top, you're still half way. The path leads underneath numerous gates, the typical Japanese tori. Some have stood there for centuries such as the eroded stone gates, but some are recent, recognizable by the material: stainless steel. Unfortunately they are also designed for the typical Japanese person, so the tall participants arrive at the top their head covered with bruises.

Although we have seen and will see such a view many times, it still is breathtaking. The cities of Nara and Osaka, yesterday appearing as a blanket of lights, are now covered under the moist air. On the top of the hill is a small temple. The spirit of the snake and the dragon rest inside of it, so we better leave them alone and start the descent.

On the other side of the hill we find the next temple. In the catacombs in complete darkness a corridor lays which holds a special assignment. Whoever grabs the sacred ball in the dark finds happiness in the near future. Most participants fail to grab, but that is no problem since we don't need luck in such a well organized trip.

Today we leave Osaka to travel to Tokyo. If Tokyo is Amsterdam than Osaka is Eindhoven. We travel by train. The Shinkansen bullet train is excellent, but making a reservation is necessary. Fortunately Johan is always here to help and we take place in our personal seat. The name Shinkansen bullet train is striking: not only the speed is phenomenal, also the way in which the rough mountainous landscape of Japan is pierced is unbelievable. Tunnels and bridges shoot by like an arrow.

The afternoon has just begun when the bullet train comes to a halt in Tokyo, capital of Japan. Immediately we notice that Tokyo differs from Osaka. It is wider, lager and a lot more crowded. Also it seems as if the people are more stressed than in the west of Japan. Surrounded by skyscrapers we set foot to Sakura Hotel, not to be confused with Hotel Sakura which is an extremely expensive five star hotel. Suddenly we stand next to a moat. In the center of Tokyo we find a castle, hopefully we will get the opportunity to visit it.

Sakura means spring blossom and the hotel shows the same color: pink. Fortunately it is a normal hotel, sporting all necessary facilities, such as multiple internet PCs.

The evening shows that Tokyo is truly a world city: lots of neon, many people and a range of different restaurants, more than in Osaka. In the district of Shinjuku, an entertainment area, you can find restaurants from every country. We have not seen a Dutch restaurant yet, but we don't want to go there. Eating mashed potatoes with chopsticks is something we can always do when we get home.

A difference between Japan and the Netherlands is the love for computer games. One of the most popular games is DDR. That doesn't stand for Deutsche Demokratische Repuplik or Double Data Rate, but for Dance Dance Revolution. You have to dance to the beat of the music while tapping on the correct lighted tile, like Michael Jackson did in one of his video clips. Does it sound strange? It is strange, but addictive. One says that even in the prestigious university of MIT in Boston, USA a DDR championship is held annually. Tokyo keeps us wanting for more, but first we have to wash our clothes (for the first time this trip) and get some sleep, we have to get up early tomorrow. Ja mata!

Morning ceremony

Temple at Shigi-san

7.2.11 Thursday 11th November

by Roland Meijerink

Some days you wish that you had stayed in bed. Some days you are very happy that you came out of your bed. Today was a day that belongs in the last category! Because of the busy schedule we cancel our visit to the Tokyo fish market, which would have required a 5 o'clock wakeup. Because the travel schedule for the evenings will be a bit less busy next week, we will make the visit 7 days from now. Especially because when you have to get up at 5, a day of traveling with the Shinkansen is better than a day full of company visits. When I left the Netherlands I was not very fond of fish, but now I start to enjoy them: not only in aquaria, but also well prepared on my dish. Hence I'm really looking forward to the fish market!

Today is the first day with professor Cock Lodder: because Leon Abelmann and professor Kees Slump had to leave earlier than planned and professor Ton Mouthaan had to cancel last week due to unexpected circumstances, we were about to have five company visits without a supervisor. Especially in a country like Japan, this was not acceptable for us and therefore we were very happy that Cock Lodder saved us by arriving in Japan a few days earlier than planned. Additional advantage for him (and to be honest, also for us) is that he can now meet with three of his Japanese friends. Yesterday he had some time to catch up with Onoue, who used to work in his group and has been a valuable help for the Shouraizou committee. Johan's impressive knowledge of the Japanese language has been greatly improved by the lunches they had together. Today at Hitachi and Toshiba we meet respectively Furusawa and Masuda: both of them spent some time at our university, just like Onoue. Masuda arranged several visits in Japan for us and spent a day in our office (which we call "toko") making phone calls and browsing the internet, when he was ''nearby" (actually: Vienna). At both companies we get a warm welcome and a very interesting program.

The morning is for Hitachi, where we get a number of lectures, because our group is too large for a tour. We get an impressive series of lecturers and subjects, but I think that the closing sheet of Inoue-san will stay in our memory the most. Aozoratenjo! He uses this Japanese word, which can be translated as "the sky is the limit", to urge us as students to follow our curiosity, to carry out ideas and to move freely in the world. A remarkable message in a country that until now seemed to be quite conservative to us, especially regarding the relationship between personnel and superiors. It is interesting to exchange ideas with him on the causes of and possible changes in cultural differences between the Netherlands and Japan, which influence innovation very much, as we have seen in our preliminary research. One of the other presentations is about EFSOT, an international project from companies and universities in Japan, the Netherlands and many other countries, subsidized by governments. This is a project on lead-free soldering, which reminds us -as electro technical students- of our practical roots.

Before we travel to Toshiba, we have some time left for a special lunch Hitachi, for the first time at a Japanese company. This lunch is served “bento”, in nice boxes, and it is very tasteful, diverse and nutritious. However, the thing that strikes me most is the fact that everybody ignores the fork and immediately starts eating with chopsticks. The Dutch invasion is already fully integrated! We arrive at Toshiba just in time (but didn’t the Japanese invent the Just In Time system?) and our hosts are already waiting for us. During our preparations, we heard that they regard our visit as an “official state call” and that is clearly noticeable. The vice-president and head of R&D at Toshiba is present and during the entire afternoon we are accompanied by a number of people that work with him and a number of leading scientists. I personally find the presentations about Toshiba and the DVD HD-technology perfect! They are very to-the-point and do not contain any unnecessary or “empty” buzz-words, which you often see in these kind of presentations. Next we get a lab tour in which, among others, we are shown a 3D-TV and a DNA-analyzer. An extensive question and answer session is the end of a very interesting afternoon. We say goodbye and leave for the hotel with the rented bus.

The trips with the bus throughout the day are a true party, by the way. Our kind 22-year old hostess entertains us with semi-informative and semi-understandable English sentences, as well with not understandable but beautiful singing and short conversations, mostly in Japanese. Of course, we reward this with exemplarily behavior, singing “de Vlieger” and taking pictures. Also we try to make sure that we don’t have to go out drinking on ourselves, next Friday night in Tokyo. The tour schedule for tonight is very simple: it’s not there! Everybody receives some money to have dinner and I go into a noodle-bar with some friends. I have very tasteful dinner, drink some Japanese sake, have a beer outside the hotel, meet with some fellow committee members and then it’s already time to go to bed. While I’m typing this, my room mates have already sawed down the first trees and I decide to follow that example. Tomorrow we have an early rise again!

Directions at Hitachi

Managers at Toshiba

7.2.12 Friday 12th November

by Joost de Klepper

Even before my Shouraizou alarm clock goes off, it becomes clear to me that today we will need the Shouraizou folding umbrella, because it is the rain ticking on the window that wakes me up. Luckily, we will be underground or visiting companies most of the day: the program contains three company excursions and a total of eleven metro rides.

After our "continental breakfast" we walk to the metro station. We have to wait for the late comers so Johan and Erik can buy day tickets for everyone: a day ticket that you should keep with you all day and never let go of. The first metro trip on two lines is a smooth one, and our host OITDA is located so close to the metro station the we miss it on our first passage. Because of our smooth journey we arrive far too early at OITDA.

The visit to OITDA is successful. Because OITDA is an association of companies it does not do technical research itself and so we do not get a tour with high-tech equipment. We do get a Japanese style lunchbox: a bento. Just like other bentos this one tastes fine, except for a sour seed in the middle of the rice. During lunch our micro research group gets the opportunity to ask their final questions for our research so we can get a beer soon after lunch. Too bad there is no time for beers now, because there are two more excursions on the program for today, so we plan our beers for tonight at Roppongi.

After lunch we quickly head back to the metro station. During our journey on three lines the black box and pal system proof to be very useful, because during the rides our group gets smaller at every interchange, but at our final destination the group gathers in ten minutes. We are picked up at the station for a short walk to the Tokyo University. On the university campus is a large modern building, which we enter. In a lecture room on the top floor we get a drink and a number of presentations.

After the presentations we get three tours through the laboratories. The whole big building seems to be stuffed with hyper modern laboratories. The first tour is at a lab for "intelligent space", where robots are controlled by sensors and cameras that are present throughout the room. There are also some examples of force feedback gloves present in this room. There is no time for a demonstration though. The next stop was at an AFM setup and after that we got to see the door of a "dirty" clean room. After a few questions we have only one excursion left before we can get to our well deserved beer.

During the metro trip to the Dutch Embassy the first people start to lose there metro tickets and they have to buy new tickets to finish their travel. The guard at the entrance of the embassy has printed out all our passport photographs, but when he sees about 35 tall white men coming towards him, he decides to open the gates and trust us.

Inside, we are welcomed in a warm, traditional Dutch way. No rows of small tables, but a circle of chairs, and when our hosts enter the room we have already helped ourselves to a cup of coffee. Together with the people of the embassy we discuss some of the strange habits of the Japanese like the billions spent on the game Pachinko. Among the rapidly passing sheets, there also is a sheet that seems to contain some of the answers to our research questions. On the request of Jasper, who is still very alert, this sheet is put back on the screen.

It is getting late already and we head back to our hotel to slip into something more comfortable and move on to Roppongi for diner and not in the least place a beer, because tomorrow we will have a day off and today we are halfway on our tour. It takes us some time to find something to eat among all the titty bars. But after a while we find a good, inexpensive noodle bar. After dinner we want to enjoy the view from the top of Roppongi Hills Tower, but unfortunately the business area of the building is closed. The commercial area is also deserted. The only thing that draws our attention is a huge poster of Arnold Schwarzenegger on the wall of one of the buildings. We walk to a small pub, with a bar that covers about half the area and that is crowded with Americans and Australians. One round of beer costs ¥5000, and that is too much for us to stay here for the rest of the night. So we walk to a supermarket and buy our next round for less than a quarter of the price at the bar.

After finishing our beers we walk back into the busier areas of Roppongi and within a few seconds five men are swarming around us. We are slightly curious about the insides of the bars they are trying to get us into, so after some negotiation about the beer price we follow one of them into a club. There is nobody inside except for five bad tempered women and a waitress. The waitress is the only one who makes a bit of fun. After she brings us a beer she wants to dance with us. I want to buy her cap as a souvenir, but I get the intention that it is easier to take home the waitress than to take her cap. Then it is time for us to go, we are all tired and slightly intoxicated. While looking for a taxi we take a picture of ourselves together with a Polish hooker. After that a taxi brings us home quickly, so we can have our well deserved long night sleep.

Japanese lunchbox

Roppongi

7.2.13 Saturday 13th November

by Erik Staijen

A day starts at midnight. Massive beats fill a small room. A man and a woman walk out of one toilet and for me it is just a guess what they have done. There is enough Heineken beer to drink and the people in the pub are staring at us, as if we are coming from the Netherlands.

Place to be: Roppongi, thé entertainment district of Japan. At this place there are people who deny every sense of real Japanese people. They talk to you, even if you don't want it. They know the best places in Roppongi with the best prices and the best beer. We choose a very pleasant pub by our own. Although our presence for the Japanese people is a bit strange, the party is even better. We attract attention because of our length. Some of us are over two meters tall and the architects of the Japanese buildings don't expect that.

We introduce limbo dancing which is very successful. The result is a free beer for all of us. A couple from New-Zealand leads us to another crowded pub. The music and the atmosphere are really good. Our communication with Japanese is getting better with some beers. This evening is good! At 5 AM we are tired and in the meanwhile the pub is not so crowded anymore. Time to go home! Outside there is a lot of traffic. Four-lane-roads are completely filled with taxis. To prevent misunderstandings, in Tokyo four-lane roads means four floors. At 6 AM we reach our hotel. We are exhausted and need a good sleep.

It is 12 AM. I jump out of the bed and get a shower. Then I wake up. I dreamed. Slowly I climb down the ladder. My head reminds me of yesterday. I realize we have no time schedule today. I want to do as much as I can because I'm not in Japan every day. My body loses the smell of smoke; my teeth are blinking as never before and with my backpack I walk with Roland and Johan to the Imperial Palace. This is the emperor's fort. We can't go inside but the garden is really beautiful. It is really fun to see that everyone in the garden feels convenient. We see authors, painters, tourists, photographers and sportsmen. For us it is the most brilliant place to talk about yesterday.

We decide to buy a day ticket for the subway. The first place we visit is Shinjuku. This is the busiest station of the world. Indeed, it is unbelievable! This is completely different from what we are used to in the Netherlands. Two million people cross this station every day. We are lucky, because we see a bookshop. It has eight floors and we stay there for half an hour. Sometimes when we walk outside we blink with our eyes to believe what we see. Tokyo is amazing. The subway brings us to Akihabara. This is world largest gadget district and that's why it is the place to be for an electrical engineering student. You can see enormous buildings with the most fascinating gadgets. It really is a great experience.

The most famous and rich district of Tokyo is Ginza. You can find famous designer clothes in the biggest accommodations. The busiest crossway is in the middle of Ginza and that is easy to see. One word can summarize this place: chaos. The

Japanese politeness is sometimes tremendous. In a big department store there are 20 people that bend for us. With star-like airs we go to the hotel by subway. We want to hear all the Wild West stories from other participants. Some people have been sleeping the whole day, others went to an "onsen" and one participant has bought a complete suitcase with souvenirs.

Professor Bram thinks we have to end this day with some beer. So we are going back to Roppongi. Let's party!

Gadget

City chaos

Tokyo by night

Pimp my car

7.2.14 Sunday 14th November

by Rogier Veenhuis

After a night out on Friday and a lazy Saturday without obligations, it is time for a sightseeing tour on Sunday.

The Shouraizou Entertainment System (SES) or alarm clock starts making music at 7 o'clock this morning. It is the beginning of a new exciting day. After defining the core business ("the creation of a well fed and awaken participant") and realizing it, we walk to the bus. We prepare ourselves for a three hours lasting bus trip to today's destination: Nikko Park. At our destination we can stretch our legs and breathe the fresh air of the forest. Nikko Park is a national park which is a good example of the commercialization of Japanese culture. The park contains impressive and colorful rows of trees and many temples. The temples are interchanged by beautiful pieces of nature. Most buildings are delightful to the eye because of the unique architecture and the pounds of gold that are used.

After visiting the Rinnou-ji, Toushou-guu and the Futarasan-jinja temples it is time to eat something because hours of walking through the park makes you very hungry. We eat some typical Japanese food. The first snack is a doughy cookie filled with currant jelly. That tastes very good! The next snacks are something like fried chicken and a super sized spear with baked meat. It really is delicious to us. Now it is time to visit a few other temples and then we have to go to the exit of the park. We come together with the other participants and walk to the bus to go to the next touristic piece of culture.

The bus drives to a lake between the mountains near Nikko Park. While we are looking at the lake and photographing it, it becomes colder. We stay outside the bus for a few minutes. We get back into the bus again and visit a famous waterfall which bridges a height of 97 meter. It is very foggy in the surroundings of the waterfall so we cannot see it very clearly. It is a small disappointment.

We drive back to our hotel in Tokyo and end up in a traffic jam from here to Tokyo. It is not a big problem, because we áre almost in Tokyo. When we arrive at our Sakura Hotel in Tokyo we change clothes, form a small group and go to a restaurant. People from Australia told us where we can find the restaurant with the best food and the tastiest beer. We go to the restaurant and enjoy the meal.

After eating we go to the Tokyo Dome Hotel. It is a very stylish hotel which contains 43 floors. With the elevator we go to the highest floor of the building. There we can see a large part of the city. The view is very impressive with all the buildings, cars and lights in Tokyo. Near the Tokyo Dome Hotel is the large Tokyo Dome and a few attractions like a rollercoaster and a giant wheel. The Rollercoaster rides through a hole in a building. That is very strange to us. Of course we take pictures of the intensively lighted giant wheel and the rollercoaster.

We walk to the hotel and at 2 o'clock we go to bed and we can look back at a day which was enjoying and interesting. It was a pleasant addition to a fantastic studytour.

On the bus

Nikko

Pagode

Foggy waterfall

7.2.15 Monday 15th November

by Michel Franken

The weekend is over, most of the headaches have disappeared and most of us haven't had as much sleep as they had initially planned. Today we continue with our micro research with renewed vigor. The companies that we will be visiting are NTT Labs and Showa Shell.

As we already have gotten used to in the Sakura Hotel, our slices of bread with jam, toasted or not, are awaiting us downstairs. We wash them down with a few appreciated cups of coffee. The bus is in the best tradition of Japanese bus companies 20 minutes early. We change our breakfast table for a seat in the bus and leave for Atsugi.

Most of us use the two hours in the bus to catch some more sleep, something the coffee could not prevent, but a few people are busy with preparing questions for the upcoming excursion. When we arrive at NTT we are welcomed by very surprised people. Due to the lack of traffic jams we have arrived half an hour early. We patiently wait and read the leaflets that NTT has prepared for us while the people of NTT prepare their presentations. In the presentation NTT and its goals are presented. We are visiting the Basic & Core Technology Research Centre and the presentation is followed by a tour along three research projects. At each stop a short presentation is given by a researcher, followed by questions.

The first project that we get to see is an optical chip that aims to simplify the construction and expansion of complex and vast optical networks and reducing the costs of such a network. The second project is pure basic research and deals with the development of a femto-laser. Now that the laser is developed, commercial and academic applications are being looked into. The third project deals with basic research into new superconducting materials.

This tour is followed by a visit to an exposition room where the latest technologies of NTT are showed and explained. The conclusion of our visit at NTT is a Q&A session of half an hour with the supervisors of the morning.

Leaving NTT behind, we go on our way to Showa Shell. Showa Shell is also located in Atsugi, but the bus drive still takes half an hour. A lunch is served at Showa Shell specially for us. It is a good lunch and when it has been finished, it is time to start the official excursion. In the presentation the goals of Show Shell are explained and the manner in which they want to achieve these goals. Due to a tight schedule only a few questions can be asked and this is therefore being done by the micro research group.

As a conclusion to this excursion we get a tour through the production- and test facilities of the company. We visit among others the clean room, where the operation and construction of the solar panels are explained. After having said goodbye to our guides and thanking them for their time and effort we return to the bus and go back to Tokyo while the sun is setting.

Today there is no organized evening program and everybody fills that time the way they want to. It was another day on which we have seen many interesting things and learned a lot about two companies in Japan.

Traffic from here to Tokyo

NTT Basic Research Centre

Getting on the bus

Tokyo nightlife

7.2.16 Tuesday 16th November

by Joost de Klepper

The tune of the alarm clock of my roomies is starting to annoy me. Maybe I should pick some other roommates in the next hotel or just ask them to change the tune. The breakfast also shows many similarities to the one we had yesterday and even the bus trip starts just like the one we had yesterday. The bus is well on time, but almost as soon as we enter the bus, we encounter the first problems. The traffic jam starts a long way before the point where it started yesterday and between the slowly crawling traffic the ambulances flash by with shrieking sirens. After an hour of traffic jams, just outside the centre of Tokyo we run into the site of an accident. A lorry driver obviously did not know which way to go and unfortunately choose neither of two directions, resulting in a huge chaos on the road. Because our driver is not allowed to drive for a long period, we make a short stop at a road house, where we can stretch our legs and Johan can inform AKM about our delay.

We arrive one hour late at AKM, where we are welcomed by some Japanese and a Dutch guy. Some of us know him by the name of Willem Stapelbroek: he followed the Japanese course together with us and he is now doing his internship at AKM. There is not much time for chitchat, because as a result of our delay we have to start with the first presentation as soon as possible. We get two presentations: one about the company and one about a number of chips being developed at AKM. Because of the high temperature and the large amount of schematics flashing by, some people have a hard time keeping their eyes open. I am very glad when Martin wakes me up to show me a sample of a chip. The discussion is moved to lunchtime because of the lack of time and we go on to a tour through the company. First we walk to a large room with 'islands' of desks. There are about eight islands with about twenty desks with people working. The room is truly mouse-silent (dead quiet): the only thing you can hear is the clicking of many mice being operated. Every island has its own project on the development of some chip.

One floor below there is a room where prototypes of the designed chips can be tested and changed by the use of "focused ion beam". After the tour we get a Japanese bento for lunch and some time for questions. Then we have to rush on to Chinatown in Yokohama for a cultural visit. Because we arrived late this morning we have to leave professor Nauta behind to help AKM with one of their designs.

When we arrive in Yokohama, we see a tall slender building. I would like to take a look on the city from the top of this building. Together with Laurens we make up a story: we are inspectors for the building inspection service and we are here to measure the humidity because Queen Beatrix from the Netherlands will soon pay a visit to Yokohama. But when the bus stops in front of the building and Roland tells us that he and Johan will collect tickets for us, it turns out that we can visit the Yokohama Landmark Tower without our weak excuse. The Mitsubishi elevators take us to the top of the tower with an astonishing speed of

750 m/min, but without any bump or even a little vibration. The only thing that you can notice about the speed of the lift is that within a minute you get a superb view of Yokohama and its surroundings. Unfortunately there are some clouds in the direction of mount Fuji, so we cannot see that. But the rest of the view is breathtaking.

We take some pictures and gather on the first floor of of the tower, but not all on the same spot. After searching for the others and then for the people that wandered off in the meantime we are back together and walk to Chinatown. Finally we can eat some Chinese. They don't serve babi pangang, but the cuttlefish, shrimps and soup also taste excellent. Because Jasper misunderstood the gathering time by half an hour we also have time for a cup of sake. When we have almost finished our sake, Jos and Matthijs also enter the restaurant and order a sake. But we have only ten minutes left to finish our drinks and return to the group so have to do a "1, 2, 3, hop-sake"! We return to Tokyo by train. In the train we do something most Japanese have never seen: playing a game of cards on the floor. When the train becomes too crowded we have to finish our game. Back at our hotel there is time for one more beer. Matthijs' toe is all swollen and purple after a wild night in the temple. Because it is hurting him he wants to visit a doctor and together with Roland he heads for the hospital. An hour later professor Nauta returns. Thanks to his help AKM can continue with their chip and they offered him a lot of beer in return. To celebrate this we have one more beer, but then it is really time to go to bed, because tomorrow morning the alarm clock will sound its annoying tune far too early again.

View from Landmark Tower

1, 2, 3... Hop-sake!

7.2.17 Wednesday 17th November

by Harald Profijt

Hello everybody! Today already starts at 7^{15} in the morning, for most of us it's still hard.. But still, some nice and interesting things are waiting for us, so we get out of our beds, enjoy breakfast and get in the bus. Of course we are equipped with a cup of coffee in our hands. Today we are going to visit the world's fastest computer at the Earth Simulator Centre.

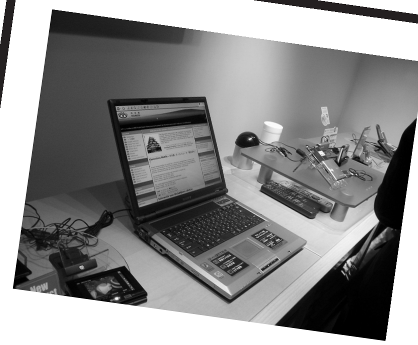
The Earth Simulator Centre is a good example of the Japanese always trying to be the best and the fastest in the world. Therefore they are very proud of their computer that's enormous in both dimensions and performance. The program starts with a few presentations about the possibilities of the supercomputer and the way it's built up and funded. Because Japan faces many earthquakes a year, this is the center's main subject. After the presentations we get to see the giant hall where the computer is situated. It's very impressive because of the size of the giant air-conditioned room with the big boxes.

After the visit, we take the bus to enjoy a lunch in Sendai. Because McDonalds is situated next to the next company we are going to visit, we order a healthy Big Mac menu. Half an hour later and with the taste of French fries in our memories, we prepare for the next visit: Sony Media World! Inside we meet both QRIO and AIBO, Sony's humanoid robot and robot dog. The lady that shows us around demonstrates the abilities by talking to QRIO. Very funny, because after the short demo she tries to shut the robot off by saying: "Thank you, QRIO." However, the robot has difficulties understanding her Japanese accented English, doesn't obey the first three times. After the next demos of a few ultra thin portable devices, audio and video techniques, we get a demonstration of Sony's new digital beamer. It works with tiny mirrors on a chips and promises to be the next step in cinema projectors. The visit ends with another QRIO demonstration: that of two QRIOs dancing, talking, listening, walking, playing soccer and communicating with their environment.

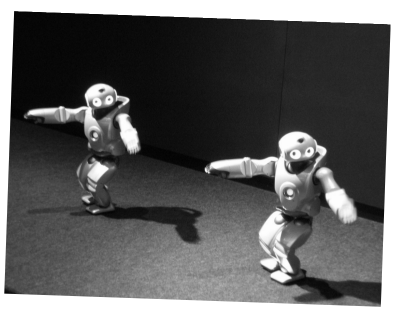
After our visit to Sony Media World the evening program is there: a dinner boat awaits us for a trip on the waters near Tokyo city. Being on the water, of course we enjoy our Japanese food, beers and sake very much. After the Japanese style dinner everybody participates in a big karaoke party on board of the boat! Because karaoke is one of the greatest hobbies of the Japanese, the committee thought we should try. And with succes: even the professors share their singing qualities with us! At about 21^{30} we are politely asked by the boat employees to take the taxi back to Sakura Hotel.

Well... The end of the evening has come, but still a few want to party. What shall we do? At 22^{00} a small group of nine persons and professor Nauta take the metro to party a few hours longer in the centre of Tokyo. For the next day a long Shinkansen trip to Sendai is planned, so we will be able to sleep a few hours during that trip. After spending an hour in some weird club, we visit Tokyo Hard Rock cafe and a very nice discotheque. After a lot of beers (also some Heineken and Grolsch) we call it a night and take a cab to the hotel. For tomorrow, also an optional visit to the fish market is planned, but most of us decide to skip it and prepare for a few hours of sleep.

Earth Simulation Centre



Sony-gadgets



The Qrio twins

Cruisin', eatin' & drinkin'

7.2.18 Thursday 18th November

by Erik Staijen

This daily report is somewhat different from what you have read so far. I will try to give you a look behind the scenes of the organization.

It is 7 AM when Johan (the travel coordinator) and I get up. Today we leave Tokyo and go to the north of Japan. We are going to Sendai, a city with a million inhabitants where we stay three nights. At 8^{15} everybody is ready to go with the subway. Johan already left us to get all the tickets and I lead the group to the right entrance of the subway. The other committee members make sure that nobody stays behind. The subway train is very crowded. We spread out over the entire length of the platform, so in each train there are some Shouraizou participants. Once we reach the destination we do a buddy check. In this way we know in a couple of seconds if everyone is there. You have to look for your two buddies. If there is a failure you shout, when your buddies are there you keep yourself quiet. It has always worked so far.

The Shinkansen is coming. It is a biplane. What a tremendous machine! With a huge speed we leave Tokyo. The storage of the luggage is a problem in such trains, because the number of storage boxes is limited. We divide the group over three carts. It works: nobody sits with luggage on his or her lap.

Within two hours we are on our destination. The city of Sendai looks peaceful. And it seems like the city is built with a policy, in contrast to Tokyo. The way to the hotel is easy to find. We ask a pedestrian for directions once, but the professors Miko and Cock know the road as well. They lived here for a couple of months 20 years ago. We soon arrive at the Ryokan, a typical Japanese hotel. No shoes inside, we sleep on futons and tatami mats and the best of the Japanese culture is of course the furo. This is a hot tub in which you can sit with several people. The rooms can be divided among the participants. There are small problems but Johan is a master in Japanese, so this can be solved easily.

Bayan distributes money for lunch and groups of five people can have lunch in the centre of Sendai. Sendai is not that big, so you meet each other often. I'm taking a bath in the furo before dinner, but that is not a good choice. When I get out of it I'm completely exhausted and it is just 6 PM.

The dinner at the Ryokan is really great. It is typical Japanese and everyone can cook the meat and vegetables in a bowl by themselves. Of course everyone sits on the ground and we are divided into two opposite rows. During the meal everyone can order a lunchbox for Saturday. We will go to Kinkasan Island then, where no restaurant is available.

All kinds of nice shops are still open and I decide to buy the brand new CD and DVD of U2 called "How To Dismantle An Atomic Bomb". In Japan CDs are very expensive and for this reason there are extra tracks on the CD which are not included in the same CD in the Netherlands. Moreover the text of the cover has been partly written in Japanese. For this reason many of us purchase a CD or DVD.

It rains all evening and we walk quite fast through the city. Before we realize, we stand in the middle of the red light district. This was not the purpose of our walk so we decide to have a drink somewhere outside this neighborhood. Once we get back in the hotel, Johan and I confer about tomorrow's bottlenecks. We are going to sleep around half past 2. About 7 o'clock our alarm clock will again play the most irritating tune I ever heard.

Bullet train passing by

More sleep, please

Slippers

Preparing dinner

7.2.19 Friday 19th November

by Lodewijk Bouwman

This day starts at a late moment; we can sleep late until seven o'clock. In normal life this would be very early for the average study tour participant. But now we are in Japan and daily life does not seem to count here. After a good night rest Japanese style on the tatami floor and a futon, the question is how the breakfast will be this morning. After the nice dinner the day before we are surprised again with a bake-it-yourself-dish of egg with bacon and some other tasty things, which apparently belongs to Japanese breakfast. On the moment we gather in front of the Ryokan for walking to Tohuku University we are unpleasantly surprised by the weather, that is rain. Fortunately most of us are the proud owners of a nice umbrella with Shouraizou logo. So all Japanese people who meet us can see which nice study project we belong to.

After the walk to Tohuku University we are welcomed at a conference room where a film about Tohoku University is presented. This film makes clear that this university owns more campuses beside the one we are at the moment. This campus area is the one with the oldest buildings, but new buildings are being built. One of the new buildings is already finished but it is quite a walk away. It has to be said that everything is relative and if it is raining distances become longer. In this building there is a clean room in which the scientists can tinker with electronics, photons and magnetism on the nanometer scale, call it rather small. After two more demos and walking through the rain, taking off our shoes and putting them back on, we arrive at the conference room for a well deserved lunch. The people at Tohuku University are well informed about our travel program through Japan. They expect that we would like to have a lunch with bread instead of rice afer two weeks in Japan.

After two presentations, with as much walks and taking shoes on and off, it is Roland who gives his presentation about Shouraizou, this time for the Japanese professors and students. We are not the only who prepared our study tour, because the Japanese want to know a lot of things, especially about the funding of the project.

For the sake of integration between students of both nationalities, we get the assignment to make a brige as long as possible, with only spaghetti and thin thread. The tricky thing about this assignment is that the bridge should be able to carry two cups of water. After some difficulties with communication and experiencing differences between both cultures, different types of bridges are built. Some of these can be called "creative": unfortunately this is the same as "unstable" and "too short". But other bridges last with the two cups of water.

After a day of presentations and building bridges it is time to go to have dinner. Together with the people of Tohuku University we go to a restaurant in Sendai where we enjoy different Asian dishes and free drinks. Because the many different cocktails and the inability for most of us to read the menu, we pick cocktails at random and order it X times. The people of the restaurant are somewhat surprised when mittsu (i.e. three) cocktails are ordered each time. Of course the food is very tasty, only it is difficult to eat the last course with chopsticks. Most of us think it is a sort of Asian "vla", but surprisingly it turns out to be made of tofu. All good things come to an end and we go to the Ryokan, where some of us get prepared to explore downtown Sendai.

Walking in Sendai's night life area it is not very clear for the Dutch what services the women on the streets offer. Most people do not dare to enter a bar. Finally one group enters a building with different small bars. A man comes out of one of these bars: he has seen us at Tohuku University and he convinces the Dutch to go to this bar. The bar is not very large, but we enjoy ourselves there anyway. Later some Japanese people join us. These Japanese are much better at karaoke than the Oranda-jin. At one o'clock the bar has to close so we go back to the Ryokan. Some people go to bed and others decide to stay awake for a short time. It has been a great day for all of us.

Singing in the rain

Discussing the bridge

The winners

Fun with Japanese students

7.2.20 Saturday 20th November

by Jasper Klewer

A desolate island with a beautiful nature, that is the destination of today. But first we have to wake up in the Ryokan. Like yesterday we are treated in this Saturday morning with a delicious municipal breakfast. The pyromaniacs among us are satisfied by the cube of inflammable fuel that heats a part of the meal: two sausages, some pieces of potato and some broccoli. There is no better way to battle the sleep than a heavy breakfast and that is necessary, singing karaoke all the night is a burden to your health and ears.

Today no Shinkansen for us, the bullet train can rest. An old-fashioned commuter train, one that stops every other minute, is the transportation of this day. At nine o'clock we leave Sendai for Onagawa, a town at the coast. Sendai, the city of trees, is a relaxed city, totally different from Tokyo. The people are warm, girls smile when you walk by and the roads are spacious and green. It resembles the cities of Berlin and Groningen. The theme of Sendai this week is the Beaujolais Primeur, everywhere there is red wine, French bread and French flags to be seen.

We have no need for this materialism, no wine for us today. Nature and spiritual rest, that is the mission of today. The island of Kinki-san, Golden Mountain, is one of the three most holy places around Sendai. It was even off limits to women until the end of the eighteenth century. Gold was found on this island many years ago, with which the Buddha statue in the Daibutsu hall of the Toudai temple was covered. As a tribute a temple was erected on the island.

The island is swarmed with funny apes. Besides the funny apes from Enschede, the Netherlands, a range of animals can be found such as deer and buffoons. The committee member responsible for the weather did an outstanding job: unlike yesterday, today the weather is excellent. Viewed from the ferry the beauty of Kinki-san is apparent, the sun adds color to the autumn leaves. The island is shaped like a raspberry and is a few kilometers wide. As can be expected from tectonically active Japan a steep hill rises above with the top at 445 meters. This will prove to be a challenge: the last ferry will depart at four o' clock, so we have to hurry.

Before the climb commences we make sure our lunch is carefully hidden in our rucksacks, the brutal deer will eat right out of your hand. But they are very cute and thus a popular model. We walk from the dock towards the temple, where the route starts. Route however, is not the right word. On the map of the island that was provided some dotted lines are drawn with the walking trails. When we get past the temple the trail appears to be a mountain stream. We climb the stream, stepping from dry stone to dry stone, the wet stones are slippery. From time to time you wonder if you are on the right track, but every few hundred meters a rusty sign or an eroded rail appears, so we know we are not lost.

Singing karaoke and having some drinks with the professor is a lot of fun, but climbing a steep hill the morning after is less fun. Covered in sweat we stumble across two Shinto statues. The Lonely Planet guide book tells us we have completed two thirds, but that the remaining part will only get steeper. This does not pose a problem since the view from here is magnificent. Now we truly have seen Japan, without the fuzz and the smog. It is too beautiful to describe, so please take a look at the photos.

On top of the hill a small temple is erected, next to a sign showing '444,9 m' and a stone table. The view is fabulous, on the right the Great Ocean, in front of us the island and on the left the island of Japan. It is chilly in this place, the ocean breeze is apparent. The colors we see are the blue of the sky and the sea, the green of Japan and the yellow, brown and fiery red of the autumn colored trees on the island.

The squawks of the raves tell us that it is time for lunch; the birds know it before we do. We have deserved are bento after the long climb. After lunch we stop taunting gravity and follow the example of the mountain water, we start the descent. On the south side of the hill it is easy to walk, there is even a recognizable trail. At three o' clock we return to the temple.

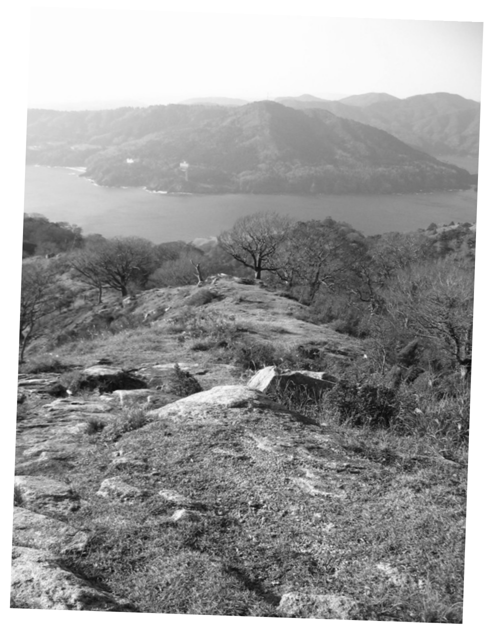
But where are the monkeys? It appears that they live somewhere further along the shore. With an hour to spare we set foot along the coast where the waves break apart on the sharp rock. On the side of the hill we suddenly spot the red face of a buffoon. While the deer almost ate the food out of our pockets, these simians are very shy. Against the mountain side we see a large family that unfortunately is alarmed by our presence. We can't climb as well as these primates so it is time to leave the island.

Exhausted but happy we sail back to Japan. Everyone is so tired that no one gets nauseous of the high waves that rock the ferry up and down. We disembark in twilight in Onagawa, the fishing town resembling Dutch Harlingen. This is the last night in Sendai, tomorrow we leave for Akita. The Ryokan thankfully provides a furo and the hot water and the physically intensive day has exhausted us, leaving us longing for the bed on the tatami. We thank professor Bram Nauta for his guidance during his presence and dive between the sheets. See your tomorrow!

Kinkasan island

Monkeys

High-speed boat



Magnificient view

Sunset at Kinkasan

It's a beautiful day

7.2.21 Sunday 21st November

by Bertjan Davelaar

Although you may get used to getting up between 6^{00} and 7^{00} in the morning, it remains very difficult to me. Possibly that's more because of the total sleeping time in stead of the wake up time, but is out of the question that you're going to bed at 10 o'clock, of course. Everybody who finds it difficult to get up today only has to move himself to the station, into the Shinkansen, and sleep further in this train. Today we travel from Sendai to Akita, our last new sojourn city. After the very Japanese breakfast, we walk to the station at 8^{00}. We find the right Shinkansen which brings us to Akita with high speed.

In Akita the weather is very beautiful again. It's a very welcome piece of good luck that we don't have to walk very far with our luggage from the station to the hotel. The hotel also looks very good and it would be nice if the weather justified the name of the hotel; Hotel Hawaii Eki-Mae. The rooms are as small as all the others we've had so far, but they contain our own sink, good beds and a nice view. Moreover it's a room for two. A room for more people can be pleasant, and it was pleasant the past time, but a room for two is a little calmer and more welcome now.

After dumping the luggage and a fast lunch we travel again by Shinkansen. These trains are accurate within seconds and amazingly comfortable, so it will be hard to travel with the Dutch Intercity again when we're back in the Netherlands...

By the way, I like it to travel by train here. In the cities we especially see the wellness and rich areas. In the train you get more to see from the country life and the villages. It seems a lot poorer and more neglected. Akita is also a small city for Japanese standards with 319,000 people living in it. Tokyo has approximately 12,000,000 inhabitants and Osaka 2,700,000. Akita seems a little more a country-life city, which is expressed in the way people react on us. We seem to be aliens to them... But because it's a smaller city, we may be also seeing a little more about poverty in Japan. There is very little social security in Japan, so I expect there has to be poverty in Japan.

What still amazes me is the landscape with the mountains and hills. They seem to have fallen into the landscape. Land is very flat and than suddenly a mountain or hill arises. Without buildings or constructions, only trees and forest. It's very well visible at pictures, quite special.

The trip with the train brings us to Kakunodate. In this village traditional Samurai-houses are located. It's beautiful to see these little houses in their environment. The interior is nice, but to us not very special any more. It looks a little the same as the temples and castles we've already visited. In the temple we slept one night, our rooms were quite the same as these houses. We walk a little around and see a nice traditional sport. It's in a building with grass in front of it, and there are female archers with huge bows. It seems that the tradition and the movements are more important then the actual shooting, but very impressive to see. Totally different from how we would do that in the Netherlands.

At 18^{17} the Shinkansen brings us back to Akita. The evening can be spent freely and we can have dinner in groups, at a location chosen ourselves. After dinner some take a Japanese bath, others visit a gaming hall.

Japanese countryside

View from the train

Samurai houses at Kakunodate

Toys not to be played with

7.2.22 Monday 22nd November

by Michel Franken

The last two universities and institutes of our study tour will be visited today: Akita University and the Akita Institute for Advanced Technologies (AIT).

We have to munch down our breakfast in a hurry, because there has been a slight miscommunication. The breakfast is not included and has to be ordered separately. In the end almost everybody acquires their breakfast in the supermarket next door. Saito-san comes to collect us in the lobby of the hotel and everybody is impeccably dressed for the last time. He guides us through Akita to the campus, where we are welcomed by the vice-president of the University. The vice-president also gives the first presentation about the organizational structure of the University and the activities that take place in the various departments.

After this presentation, another presentation is given by the principle researcher of VBL. VBL is one of the institutes of the University and a lot of chemical research is being done on various ecological issues. VBL tries to develop technologies with which venture businesses can be started in the region. The recent privatization of the universities in Japan has made this process more difficult, because there are less funds available. The activities of VBL are further explained by a poster presentation. Approximately 27 projects are explained by various researchers of VBL. The researchers, mostly PhD-students, are very friendly and eager to explain and discuss their projects. They also give a lot of information about what it is like to work at VBL.

A camera team of the local television station is present during the poster presentation. Several people from our group find themselves staring at a camera answering several questions. Saito-san promises to record the broadcast.

The poster presentation ends around lunch time and several students guide us to the canteen. The professors are invited for a lunch with the full board of directors. On our way to the canteen we are surprised by the attention we get from the local students. Apparently not many foreigners visit in Akita, because people literally hang out of windows to see us.

The lunch is really good, especially the vegetarians among us had a good meal. For the first time in Japan they could order things like a vega-burger. All sorts of dishes await us and all we have to do is pick the ones we like and it all tastes great!

After lunch we go to the local mining museum on the campus. Akita is a former mining city and samples of the various minerals that can be found in Akita are on display together with minerals from other parts of the world. Jasper finds a rock that bears his name and appropriately it is located next to a rock called appetite.

When it is two o'clock we have to leave the museum behind and go to the AIT. There we are welcomed by professor Uechi, a good friend of professor Lodder, and he gives an entertaining and educating presentation about the historical relationship between our two countries. He concludes his presentation with the factors that he finds important for innovation.

Because the presentation of professor Uechi lasts longer than expected, the second presentation is skipped and instead the guide through the facilities of AIT is started. These include among others a clean room and several testing rooms like an anechoic room.

The final part of the day is a party organized by Saito-san in the canteen of the University. A lot of employees are present and after the official speeches we toast under guidance of professor Lodder. First the Japanese do the Dutch toast "Proost" and then we do the Japanese toast "Kampai". The Japanese are startled by the volume that is produced when 36 Dutch people say "Kampai!" Saito-san has arranged several tables with small snacks and these taste very good. Many of us are going to miss the Japanese food when we are back in the Netherlands.

The committee interrupts the party to thank several people, among which of course the professors present and especially Saito-san for arranging everything. Business cards are exchanged at the end of the party and several pictures are taken. It is a successful ending to a successful day and all that remains for us is to pack our bags and spend some time in the furo and sauna of the hotel. Tomorrow we start with the voyage home, first stop Tokyo!

Camera team at Akita University

Asking professor Uechi questions

7.2.23 Tuesday 23rd November

by Roland Meijerink

All the good things come to an end. This law unfortunately also applies to study tours: this is the last full day in Japan, before we board the plane to Amsterdam. I have to admit that I do not fear the imminent end. The last few weeks have been very tiring and the last few days I noticed that I was not only physically, but also mentally exhausted. I raise less questions, discuss less sharply and absorb less information than I normally do. Today we have to move from Sendai to Tokyo, from North to Middle Japan, from quiet to busy.

In the morning we have our last chance to enjoy the furo: the traditional hot Japanese bath (a kind of Jacuzzi without bubbles), in Hotel Hawaii Eki-mae we have an extra hot edition with waterfall and sauna. Breakfast again consist of the well-ordered and legal looting of a local supermarket. I sometimes wonder how staff members look at us: suddenly 35 tall, noisy, incomprehensible and above all hungry monsters enter your store and double your turnover so far. Some local stores even welcomed us for over a week, until we did not show up anymore overnight. Imagine you have just hired extra personnel...

Traveling with the Shinkansen is not very special anymore; the four-hour travel is just a bit longer than normal. A short research while walking through the train reveals that there's not a lot of talking and there is a lot of sleeping. One could say that everybody has finally adapted to the local customs. It is still striking that despite the liveliness in Japans it's generally pretty silent. A group of chattering and laughing Dutchmen is very out of place, then. Since I'm still not really into sleeping on trains, I entertain myself with calculating the Jacobian for the transformation from Cartesian to spherical polar co-ordinates. I've got nothing better to do. At Tokyo station we say goodbye to Cock Lodder, who takes an earlier plane tomorrow than we do and therefore stays at a hotel closer to the airport.

Everybody has the afternoon off: Bayan gives out money for today's and tomorrow's lunches and I hope that everybody is smart enough not to convert the complete budget into souvenirs and (tonight) into beer. After an extensive lunch in a noodle-bar I can hardly find any time to let a Japanese person write my name down in Katakana (Japanese writing) on a piece of cardboard and to buy a special Japanese edition CD from my favorite band. We meet at 6 o'clock at the hotel to have dinner together and to officially wind up the study tour. There are so many things left to do and to see in Tokyo: a good reason to come back sometime!

The last supper takes places in a restaurant that Erik and Johan have made reservations for: we have agreed that we can have dinner for two hours and that all alcoholic drinks are included. A nice deal for us, because tonight we can finally have a very big party and the participants are eager to use this opportunity. Of course this is the moment for me as a chairman to do a speech and to thank the participants. More than three weeks ago, as we were driving to Schiphol Airport, I said that both the committee and the participants had made me proud with the preparations for the tour and that I hoped that everybody would make me even prouder. Looking back I can now say that they have proven themselves. As a committee we haven tackled many problems and we always did this without much trouble. The participants have been very curious and respectful to our Japanese hosts and hostesses. Thanks to the participants, the study tour has grown into a 'window of opportunity', a time to raise questions, meet people, gather information, just like the committee wanted it to be. Now we have the challenge to combine this information in the micro-research and the final report, which will be presented at April 1st during our closing meeting. Miko Elwenspoek puts it into words very well during his talk: everybody did not behave student-like at all.

The last night proves that the proverbial switch has been in a very special position, since it is switched completely the other way around. Tonight 34 exuberant Dutchmen fully enjoy Tokyo's nightlife, guided by a girl from New Zealand that lives in Tokyo and that we met last week. After some negotiations with shady representatives of local pubs and bars we end up in a Karaoke bar in which we can drink as much Japanese-style cocktails as we want. Japanese-style means: syrup with a water-like fluid and a lot of ice. Not everybody is convinced if there's even alcohol in it, but the ambiance is very well and it only gets better throughout the evening. Do you want to know details? You can learn them by talking to a participant or looking at the pictures. They say more than a thousand words. The party continues all night and it is the perfect end of a brilliant time!

Last dinner in Japan

The end

7.2.24 Wednesday 24th November

by Sebastiaan van Loon

"What, where am I?" That's the first thought that comes up today at 7^{15}! Maarten wakes me up, because the airplane will not wait for me. Fortunately I am not the only one. The rumor is that more people are having trouble with getting out of their beds. But this is not so strange, because last night was our last evening in Japan! So we had to have a drink on that, and another one and another one and... In short: it is a miracle that everybody found the hotel again!

After some cold water on the face and some water to drink, I am ready to have my breakfast. After lots of effort I am able to eat two white pieces of bread, but some people have more trouble with it and have to use the toilet. Around 8^{00} some sleepy participants are ready to depart. Jasper, Siebe and some others are waving us goodbye, because they are staying in Japan for one more week!

First we have to travel with the subway to the rail station, Tokyo Station. As always, the "blackbox" principle is used: everyone for himself and we'll see how many participants make it to the end point. Also this time the system succeeds and everyone manages to get to Tokyo Station in time. Here we board the train to Narita, where we arrived at ten o'clock. On the platform are the first customs officers waiting for us, so we have to say goodbye to Johan, Erik and Thomas who traveled with us until the last part of our trip. They will also stay longer in Japan. After the customs we have to check in our baggage at the JAL counter. Some suitcases have clearly put on weight by souvenirs and annual reports of all the companies. After the check-in everybody is free to hang around at the airport.

Most participant look for a place to eat with easily digestible meals and the last yens are spent on nice souvenirs for the people at home. At one o'clock we have to gather at gate A66 to board the airplane and three quarters of an hour later the plane takes off and we leave Japanese soil. See you again Japan, until next time!

After takeoff the watches are set eight hours back in time and the pilot excuses himself for the delay (ten minutes). Also the temperature at arrival on Schiphol is mentioned: 8 degrees centigrade. That is why we had to bring a warm sweater with us! What a difference with Tokyo, were we could walk without a jacket through the city. But we are not there yet, first we have an 11 hour flight! We are entertained by nice movies, music and video games. For the meal we can choose between Western or Japanese food. I choose Western because I want to let my stomach get used to the Western food. But also in this packet was fish, seaweed and a mussel. Welcome back to Europe!

The flight ends with a spectacular landing; especially the view of Amsterdam by night was great. Our country is so small, that the landing already begins in Germany. After we set foot on Dutch soil, we have to pass a drug dog. I think it's a pity they addict the dog, so he is searching the rest of his life for drugs! Fortunately they do not find anything and we can stand in line at the customs. There is already a group of parents and girlfriends waiting for some of the participants, but some of us go by train to Enschede themselves. This last trip, I think, is a hard one. Such a difference with Japan! In the train there are people calling loudly, everybody is talking with each other and they are complaining about our suitcases that we have put on the chairs. OK, they are a little in the way, but in Japan nobody had a problem with it. At Deventer we have a delay, because another train is late. This never happened to us in Japan!

In Enschede it is freezing outside and after a walk I am finally home! What a nice feeling to come home and to see that everything is still the same. And to shower in your own bathroom and not to share your tub (I don't have a tub, but still I don't have to share it)! It has been a fantastic journey, but the feeling of coming home is always a good way to end a beautiful trip!

Narita Airport

Some final Japanese culture

It's a long, long way

Welcome home!

Chapter 8

Contract research assignments

As part of the study project every participant worked on a so called contract research assignment. This assignment holds a project to be fulfilled by a student participant for a third party in a fixed amount of time, being 120 hours for every participant. For the contract research assignments Shouraizou defined the following goal:

"A student participant will work on a contract research in order to earn money for the study project making the study tour affordable for the student participants. Also a student participant will gain new knowledge, get some relevant work experience and get in contact with a possible future employer."

Now, looking back, it can be concluded that Shouraizou succeeded very well in reaching their goals for the contract research assignments. Shouraizou raised enough money to organise an affordable study tour to Japan and every student participant has been provided with a challenging assignment. Our principals together with the project assignments have already been presented in the preliminary report. In the next sections of this final report the outcomes of the projects and the experiences of the participants are presented.

8.1 Capital Turbines

Website: http://www.capitalturbines.com

Participant: Sebastiaan van Loon

Project: **Coal Gasification**

Capital Turbines is a company that is working hard to become a world class energy service provider. In four years it grew rapidly by selling mainly gas turbines over the globe and it has offices in Australia, Chile, The Netherlands, Indonesia, New Zealand and USA. They provide complete EPC (Engineering, Procurement and Construction) services for a project, including equipment sourcing, as well as full Operation and Maintenance.

In the energy business a lot is changing. Prices of fuels are rapidly fluctuating and environmental regulations are intensifying in different countries. New developments are made in the coal energy business. Coal is one of the fuels that is still available at large quantities, although coal power plants nowadays are criticized for their pollutant characteristics. A lot of research is done to limit these emissions. One of these technologies is called gasification, which is a conversion of solid and liquid materials, such as coal or oil, into a gas of hydrogen and carbon monoxide. It is a technology that has been used for over hundred years for various applications, like domestic heating and lighting, chemicals manufacture and the production of petrol- and diesel-substitutes.

Capital Turbines wants to enter this market because the gas that is produced by the gasification process can be used in gas turbines. New customers around the globe are interested in these new ways to generate energy. They are very efficient and don't pollute the environment. The newest technology with gasification is called integrated gasification combined cycle (IGCC) which combines the gasification technology with technologies that make the plant more efficient. Nowadays there are several big IGCC projects running worldwide, sponsored by governments and institutes.

IGCC plants are still at the demonstration phase and nearly all of the projects have required some form of government support. Although the costs are decreasing rapidly due to new improvements and optimal designs, it is still not a common technique that is used. Also IGCC plants have so far suffered from relatively poor reliability.

The main goal of the case study was to show the different gasification processes with their advantages and disadvantages. Also some projects are explored where the new technologies are tested. The case gives a global overview of the new technology and presents several projects were the technologies are demonstrated.

Capital Turbines itself has a relative small work force. The corporate office is situated in Perth (Australia) where a solid staff coordinates and realizes all projects. The other offices such as in the Netherlands are sales and representative offices. On project basis personnel is hired. This gives the company a flexible environment which makes it capable to undertake different kind of projects and new technologies. But it also means that they have to acquire their technological knowledge through other companies.

8.2 Heijmans

HEIJMANS

Department:	Infratech B.V.
Website:	http://www.infratech.nl http://www.heijmans.nl
Participant:	Bert van den Berg
Project:	**Transmitting-sensor data via RS232**

8.2.1 About Infratech

A Contract Research was done for Infratech (http://www.infratech.nl), this is an engineering bureau, which operates within the Heijmans organisation (http://www.heijmans.nl). Heijmans is a well-known company within the civil construction industry of the Netherlands.

Within Heijmans there is a group HST (Heijmans Special Techniques) that is, among other tasks, responsible for the detection of explosives in new building areas. This Unexploded Ordnance Detection (UXO) finds place in cooperation with the mine detection and clearance service of the army. This is mainly necessary for building areas for which the presence of unexploded bombs/ammunition can be assumed.

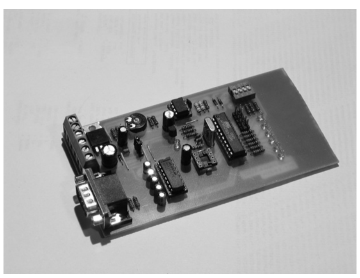
8.2.2 UXO

The earth is surrounded by a homogenous magnetic field. This magnetic field is distorted when a piece of ferromagnetic material is present. The distortion can be measured and contains information about the size and the depth of the ferromagnetic object. Bombs and UXO contain a large amount of steel or casted steel which is highly ferromagnetic. This method can be used for detection on the surface, in boreholes and under water. Today this detection is computerized with automatic calculation of object location, size and depth.

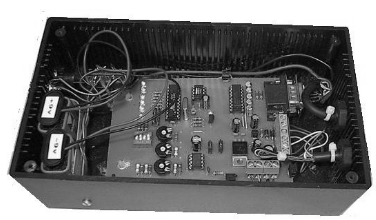
8.2.3 Project description

For normal UXO detection an employee will walk across the area following a certain pattern. The measurements together with the coordinates (GPS) are stored and they can be processed using a computer later on. For the safety of the employees it is desirable to measure remote with real-time processing of the data.

Within this Contract Research a circuit was developed to serve this task. The existing sensor generates analogue sensor data, which is converted to a digital signal. This data is transmitted via a RS232 connection. At the other end of the line the data is converted back into the original analogue values to ensure the correct behaviour of the whole. In figure 8.2.3 the resulting prototypes can be found.



(a) Circuit at transmitter side



(b) Circuit at receiver side

Figure 8.1: Pictures of prototypes

8.3 MESA$^+$ Research Institute

MESA+
Institute for Nanotechnology

Website:	`http://www.mesaplus.utwente.nl`
Participant:	Lodewijk Bouwman
Project:	**Management Assistent**

8.3.1 About MESA$^+$

MESA$^+$ is the largest research institute of the University of Twente. The institute trains graduate students and PhD-students and conducts research in the fields of nanotechnology, microsystems, materials science and microelectronics.

8.3.2 Introduction

MESA$^+$ was formed in 1999 as the merger of two institutes: MESA and CMO. It goal remains to do excellent research and train researchers in nanotechnology and related areas and to create economic spin-off activity. MESA$^+$ uses a selected number of Strategic Research Orientations and active business development to achieve these goals.

These choices have proved their value. MESA$^+$ has shown a stepwise increase in output (Ph.D students, externally funded projects) and continues these levels. It has achieved considerable national and international visibility and impact. Its concept is used as a best practice example for research organizations in other places.

8.3.3 Project description

One of the tasks of my assignment was to collect all reports of PhD theses done at MESA$^+$ both digitally and printed, for promotional purposes. Other tasks included supporting the management in optimizing communications with external contacts.

8.3.4 Working environment

Characteristic for the working environment at MESA$^+$ is the informal atmosphere where people are willing to help. Furthermore it was possible to give personal input in the approach of solving the problems of the assignment.

8.4 Océ Technologies

Printing for Professionals

Two participants have been working on two projects for Océ Technologies. First Océ Technologies will be introduced. Then each project will be discussed separately.

8.4.1 About Océ Technologies

About 125 years ago, pharmacist van der Grinten was looking for new activities, and found one in the research for butter dyes. This occasion is known as the birth of Océ. After developing all kinds of dyes, inks and the blueprint paper O.C.(from which the name Océ is derived) the company developed printing and copying technologies. Now, Océ is one of the leading suppliers of printing systems and document solutions for larger organisations.

Océ has its headquarters in Venlo, the Netherlands. Also in Venlo the largest part of the R&D department and the production department is housed. Océ has branch offices in 30 countries and about 23.000 employees throughout the world. For the development of new product Océ uses technologies developed in its own R&D department. This way Océ optimises the exchange of information and also can maintain the high standards for productivity and usability of its products. To be able to maintain its position on the market, Océ has to develop new technologies and experiment with new ideas.

Océ Research and Development is organized within Océ-Technologies B.V., which is a subsidiary of Océ N.V., the parent company. The Océ Group headquarters, the R&D department, the production facilities and the international marketing division are all situated in the city of Venlo, the Netherlands. The Océ Group employs 21,000 people worldwide and realized a turnover of 2.8 billion euro and a net profit of 61.5 million euro in 2003. Océ-Nederland B.V. is headquartered in 's-Hertogenbosch and is responsible for the marketing, sales and support of the Océ products and services in the Netherlands. Océ's customers are mainly active in office environments and in industrial and graphical sectors.

Océ's mission statement is to enable people to share information. For this purpose, Océ offers products and services to (re)produce, present, distribute and manage streams of documents. The portfolio comprises software, copying and printing systems and materials. Additionally, the company offers its customers a wide variety of innovative services in the field of consultancy, outsourcing and financing.

Océ tries to establish a leading position on the world market, with advanced products that excel in high-quality, reliability, productivity, durability and user and environment friendliness. The line of products is being developed and produced mostly in-house. Seven percent of the annual turnover is invested in research and development.

Through direct sales and service, Océ is able to offer professional support. For this reason, Océ has always actual market information at one's disposal. This enables the company to react to the needs of the customers adequately.

8.4.2 Project 1: Half toning algoritm

Department:	Research & Development
Website:	`http://www.oce.com`
Participant:	Joost de Klepper
Project:	**Half Toning Algorithm**

Project description

My contract research covered one of these new ideas. My task was to find out more about the possibilities of a new iterative algorithm on a parallel processor. The main conclusion was that iterative algorithms can not be easily adapted to parallel platforms. I did some suggestions for future research on this topic, mainly on things you have to think about when you want to create such a mapping and how to speed up the different processes.

Experiences

Océ does research in many domains of electrical engineering because modern copiers include a lot of electronics, from the control of the paper flow to high speed image processing and large data storages.

Since I have done my contract research at home, I cannot tell much about the atmosphere at the company but I will give a short impression. Most new employees who just graduated start at the research department and later on go to the development and engineering departments. So the average age at the research department is relatively low. The atmosphere can be described as a typical dutch atmosphere with a coffee machine in every hallway. There are large project rooms with open printers and copiers all over the buildings. All together Océ seems to be a very interesting place for an industrial training or to start your career.

8.4.3 Project 2: Paper sensor

Department:	Research & Development
Website:	http://www.oce.com
Participant:	Niek Bouman
Project:	**Paper Sensor**

Project description

The contract research assignment that I carried out under supervision of Ir. P.J.M. Opheij, dealt with a new paper sensor concept. An important goal of this concept is cost reduction. Another characteristic of the concept is the expected increase in accuracy and reliability of the sensor. My task was to carry out several optical measurements and analyze the electronic circuit and the sensor software. I enjoyed working for Océ, the assignment was very interesting and the contact with the supervisors was pleasant.

Career possibilities

Océ is a very high-tech company and the possibilities for electrical engineering students are innumerable. Students can always apply for internships and graduation assignments.

8.5 Philips Applied Technologies

PHILIPS

Department:	Philips Applied Technologies
Website:	`http://www.apptech.philips.com`
Participant:	Michel van Dijk
Project:	**Literature study on micro-mechatronics**

8.5.1 Project description

The goal of this research assignment was to explore ongoing activities in the field of micro-mechatronics. The main part of this research was concentrated on the current activities at the MESA$^+$ research institute. These activities are actually the research which is carried out at the chair of Transducer Science and Technology, under the supervision of prof. dr. Miko Elwenspoek and dr. Gijs Krijnen.

8.5.2 About Philips Applied Technologies

Philips Applied Technologies is a division of Royal Philips Electronics, located in Eindhoven, The Netherlands. The core business of Philips Applied Technologies is to take a product idea from research and to develop it into an industrial application. This means that Philips Applied Technologies does not focus on basic research (as is done at Philips Research at the Hightech Campus), but it merely concentrates in developing products or industrial processes from the knowledge that has emerged from the research already carried out.

Philips Applied Technologies does not only develop for the main company, but also offers it services to selected external contractors. It has for example developed much of the mechatronics of ASML's famous TwinScan wafer stepper.

The main competences of Philips Applied Technologies are divided in:

- Process technology;
- Production technology;
- Electronics;
- Innovation and Industrial Support;
- Mechatronics;
- Environment;
- Packaging development.

The research I carried out belongs to the Mechatronics division. The description of the core business of Philips Applied Technologies directly explains the relevance of this research assignment for the company. Philips Applied Technologies likes to know what is happening in the research field of micro-mechatronics at present, in order that they can anticipate on future developments. Techniques that are currently under development can be applied in new product development in the near future.

In short, one could say that three ingredients are needed have successful innovation. At first, generation of new technology is needed, which is done by basic research. Secondly, this knowledge has to be incorporate in new products or technologies. And finally, marketing is needed to successfully bring a new product to the market. The function of Philips Applied Technologies is to facilitate this second role of creating new products and new manufacturing technologies.

8.6 Philips Research

PHILIPS

Department:	Philips Research Labs
Website:	http://www.research.philips.com
Participants:	Rogier Veenhuis Frank van der Aa
Project:	**Design Temperature Sensor using Nano technology**

8.6.1 About Philips Research

This contract research was carried out for Philips Research in Eindhoven. This is a part of Royal Philips Electronics, which has 165615 employees (consolidated) in the second quarter of 2004 and has departments in 150 countries. The headquarters are in Amsterdam. Royal Philips Electronics has 60 different businesses divided over five divisions: medical systems, consumer electronics, domestic appliances and personal care, lighting and semiconductors. Royal Philips Electronics contains also specialized businesses, i.e. communication, advanced metrology systems, high tech plastics etc. Philips research Eindhoven is a part of the total R&D of Royal Philips with a yearly spending of 2613 million Euro (9% of total sales (2003)).

8.6.2 Project description

The goal of this research assignment is to design such a circuit in a standard 90nm CMOS process, which can measure the on-chip temperature. It shows if the temperature is above a specified temperature or not. The main requirements are:

- The smallest possible mismatching;
- The smallest possible chip-area;
- The highest possible accuracy;
- Pre-determined low voltage supply.

The measurement method was free to choose, but it had to meet the above requirements.

This assignment is carried out by IC-design at the UT on the third floor of the Hogekamp building. The communication with the constituent was by mail and some meetings at the UT. Unfortunately we have been to Philips Eindhoven for only one time, so it is very difficult to define the atmosphere in the company. We think Philips Research Eindhoven has a relatively young population from various countries all over the world.

The equipment that was used for the assignment was a PC with some specific software as Pstar (simulation tool), Cgap (graphical interface), Promost (tool for calculating properties of mosts), Pelican (schematic design tool for generating netlists).

We started the contract research by studying literature to find out what the possibilities are to create an on-chip temperature measurement circuit. Different temperature dependent components which are predictable with respect to their behaviour were investigated, i.e. resistors and semiconductors. The best option was a PN-junction (semiconductor) made by a transistor (PNP) used as a diode.

The main part of our research was concentrated on bandgap references (BGR). We experienced that BGR were the best method to create a temperature measurement system. We had to take a voltage supply of 1,05V into account so we used a BGR which is able to deal with such low voltages. For an opposite temperature behavior of the BGR we used the temperature dependency of the diodes.

The scheme contains diodes that create CTAT voltages (Complementary To Absolute Temperature). With the use of an OpAmp there will be a PTAT voltage (Proportional To Absolute Temperature) across a resistor, because of the diodes have different areas. This resistor converts it to a PTAT current. By copying the current and convert it to a voltage with use of another resistor, it is possible to compare the created PTAT voltage with the CTAT voltage. This is done by a comparator. When the voltages of both lines are equal, the temperature is known. By shifting the PTAT voltage line we can adjust the temperature at which the system has to act.

To achieve a high accuracy of the measurement a large gradient of the difference of the PTAT and CTAT voltages is demanded. To increase this gradient a higher dependency on temperature of the diodes is needed. The temperature dependency of one diode is only about -2mV/C. With using two diodes in serial, instead of only one diode, we have solved the problem of the small gradient. With this configuration it is very important to deal with the threshold voltages of the diodes because of the low power supply. By using a capacitor we can achieve a temporary higher voltage supply and by immediately measuring the temperature, it is possible to cope with the threshold voltages of the diodes. On this manner we can measure the temperature with an accuracy that is about twice as much as with only one diode.

After a lot of simulations and calculations, now there is a circuit which meets the requirements and an accurate on-chip temperature measurement system can be realized in a standard 90nm CMOS process.

8.7 Royal Netherlands Naval College (KIM)

Two participants have been working on two projects for the KIM. First the KIM will be introduced. Then each project will be discussed separately.

8.7.1 About KIM

KIM is the abbreviation of "Koninklijk Instituut voor de Marine" which is Dutch for the Royal Netherlands Naval Collage. It is located in the North-west part of The Netherlands, in the Dutch main naval port, Den Helder. The aim of the Royal Netherlands Naval College is to provide the Royal Netherlands Navy with well educated, well prepared, well motivated officers.

The KIM is engaged in the following things:

- It provides the initial training to become a naval lieutenant.
- It carries out fundamental and applied research in different areas.
- It organizes lectures and symposia.
- Both in education and in research the KIM maintains relationships with many partners inside and outside the Royal Netherlands Navy.

The KIM is the "University" of the Royal Dutch Navy. It has all the things you usually see on other universities. The level of education is comparable to other scientific studies in the Netherlands. Besides that, the students of the KIM practice a lot of sports and they are taught to evolve a sense of responsibility, perseverance, solidarity and other important qualities of character we would expect of a naval officer.

Students have to follow an educational training for 4 years, which includes in-house colleges and field-training. The KIM is a boarding-school so the students live, at least for the first three years, at the KIM building altogether to get used at living closely in groups when they are on missions.

Research at KIM focuses at naval topics: to optimize fuel usage, to get better object detection methods using all kind of techniques, or to get better and to optimize the usage of a sensor suite depending on the mission and environment. The main research targets and philosophies of the Royal Netherlands Naval College are divided in the following departments:

- Maritime Management
- International Security Studies
- Maritime Engineering
- Nautical Sciences
- Combat Systems Department

8.7.2 Project 1: Signal processing

Department:	Combat Systems Department
Website:	`http://www.kim.nl`
Participant:	Kasper van Zon
Project:	**Signal Processing**

Project description

My contract research assignment took place at the Combat Systems Department. The main task of this department is to provide research and education in the areas of sensor- ,weapon- and communication systems. The department provides courses in subjects as: control engineering, electrical engineering, statistics, information technology, physics etc.

The goal of my assignment was to give third year students of the Royal Netherlands Naval College a course in (digital) signal processing. The course had actually already started before I came to the KIM, but the teacher who provided the course in the past suddenly left the institute a few weeks after he started the course. Another thing was that he also took the study material with him. The staff of the department of Information & Weapon Technology then had to find a substitute on a very short notice. They then decided to contact the Shouraizou study project.

The result is that they had attracted me to continue giving the lectures on signal processing. As a consequence the students had to start all over again with the course and that I had to provide the course in about one third of the time of the usual course in signal processing. This sounded as a quite a challenge.

The course consisted of five lectures and practical assignments. Each lecture took about 2 hours and after each lecture the students had spend the two remaining hours on the practical assignments. They had to do these assignments by using MATLAB. After the five lectures, the students had to complete the course by taking a oral examination.

Experiences

At first it was quite odd to suddenly stand before a class of students. First of all I had not had much experience in teaching and secondly the student were almost as old as me. This actually had some advantages. I could easy level with them, most of the time they just treated me as "one of them". Besides, as an electrical engineering student, in de past I also took courses on signal processing. So I knew which aspects of the course some students could experience as difficult. The composing of the MATLAB assignments was another thing I had to do. I was afraid that this would be quite hard en could take a lot of time. Fortunately Prof. Dr. Ir. C.H. Slump was willing to help me with this. He provided me with a lot of study material and he also wrote some assignments for me. Taking this all into account, I can say that I am satisfied with the way I fulfilled my contract research and that I can look back at it with a good feeling.

8.7.3 Project 2: XML

Department:	Combat Systems Department
Website:	`http://www.kim.nl`
Participant:	Maarten Bezemer
Project:	**XML**

Project description

The department in which I did my assignment needed an online curriculum for their students, enabling them to look which courses they have in which period. In order to collect the data from the teachers a database was set up. This data is used to automatically create a program book containing all information on the curriculum, by exporting the data to an XML file and then converting the XML file into LaTeX.

Using this XML file, I had to create an overview of all courses and periods, including several search possibilities to find courses on several ways. Additionally the students should be able to add optional clusters of courses they choose to do in their final years, to the overview. My supervisor was Commander O. Boot. He helped me a lot with XML references and computer software so I could complete my assignment more easily.

At the end of my assignment all of the requirements were completed, however as expected, during the assignment some other ideas emerged which could not be completed during the assignment period. This means some development work needs to be done to complete the overview. Then the overview will be published on the local network of the KIM and on a CD.

Working at the KIM

The KIM is not really looking for Electrical Engineers, since it is mainly an educational institute. But of course the students are having Electrical Engineering courses, so the KIM could employ Electrical Engineers as a teacher or as researcher.

Another possibility for graduated Electrical Engineers is to follow a short naval training course at the KIM, and then work as Weapon Engineering Officer on Royal Netherlands Navy ships and shore facilities, in the field of sensor-, weapon, computer- and communication systems.

Conclusion

My assignment at the KIM was very nice and a good opportunity to meet people working at the navy and to learn much about the navy. I have also seen that the people are very collegial to each other and that working at the navy is not only being far from home on long missions but also contains periods in which assignments ashore enable Naval Officers to do all kind of supporting work, including research.

I have learned a lot about XML and how to use it to create dynamical pages depending on the user input. So I am very glad with the assignment at the KIM.

8.8 Schröder Auto-Totaal

SCHRÖDER AUTO-TOTAAL

Website:	http://www.schroderautototaal.nl
Participant:	Pieter Cuperus
Project:	**Designing and Building a Prototype**

8.8.1 About Auto-Totaal

My contract research had to be done for the company Auto-Totaal established in Tubbergen. This company is a full grown company. In the early days of this company it was specialized in revising generators and starter motors. This was the result of a hobby which got out of hand, the owner was a real electrician. Meanwhile the company is relatively large compared to the competitors and is distinctive because of the new carwash. A carwash that uses textile brushes in stead of normal brushes, for clean and scratch free cars.

The owner is a inventive and innovative man, who likes to solve everyday problems. An invention that came to my attention was the invention of the odor-free toilet, the invention was simple but very effective. A bunch of money, effort and time were spend by trying to receive a patent, but unfortunately it did not work out. The idea was already patented.

8.8.2 Project description

The new carwash that washes thousands of cars yearly, demands infallible behavior. Because infallible behavior is very convenient but unfortunately not feasible, the demand was created to make a small device that could "do" something in case of a failure of the car wash, so the possible failure could be fixed in a short time. The contract research was to create a prototype of this device. This device was build around a microcontroller, had a LCD and was fed by a solar panel.

8.9 Spark Design Engineering

Website:	http://www.sparkdesign.nl
Participants:	Matthijs Krens Casper Smit
Project:	**Lighting System**

8.9.1 About Spark Design Engineering

We were given an assignment by Spark design engineering which is an engineering consultancy. Spark design engineering is an engineering consultancy that conceives industrial designs for industrial and consumer products. It was formed in 1997 uniting NoorderBreedte design consultancy and Vici Product development. Based on client requirements it can completely develop a new product from start to finish including filing the required patents and making the product ready for mass production or just work as a sounding board for a companies marketing department. To do this the company depends on its 17 employees and their firm relationships with numerous other people and companies. These include amongst others, universities, patents agents, suppliers and prototype makers. The 17 employees are mainly engineers with an interest in design and designers with an interest in engineering. If a client requires knowledge that is not available inside the group of employees they can turn to their connections to outsource the specific part of the assignment.

8.9.2 Project description

The assignment we got was for a product made by Tieman Group and consisted of designing a CCFL Inverter. CCFL means Cold Cathode Fluorescent Lamp and is the light source used as a backlight for TFT screens. Our inverter had to drive two tubes with a voltage of approximately 800 Volts. As CCFLs have to get a jump start, an ignition voltage of 1300 Volts has to be applied to the lamps to start burning. The brightness of the lamp had to be varied so the current through the lamps varied between 2 and 10 milliamps. The frequency with which to drive the lamps would be in the region of 35 Kilohertz. The challenge was to get these voltages out of the inverter with the inverter being fed with a 12 V DC source. The main goal on this assignment however was not the inverter itself but clearly documenting the design process and design parameters so Tieman and Spark could use the gathered knowledge.

8.9.3 Research project

For this assignment we first searched the internet for information and found out that most inverters use a so called Buck Royer Oscillator to obtain the desired frequency and voltage. The Buck Royer oscillator requires a transformer, a high power inductance, a high power capacitor and two high power transistors which are expensive and rather large. The current monitor can be bought as a single chip solution from various sources and as we said most use this design. One other company however uses something they call direct drive which means the oscillator frequency is not dependent on variables from the transformer, inductor and lamps but directly by the controller chip itself and the capacity at one of its pins. This reduces the number of high power components by eliminating the need for the inductor, the capacitor and it also simplifies the transformer. A comparison between both simplified circuits can be seen in figure 8.2.

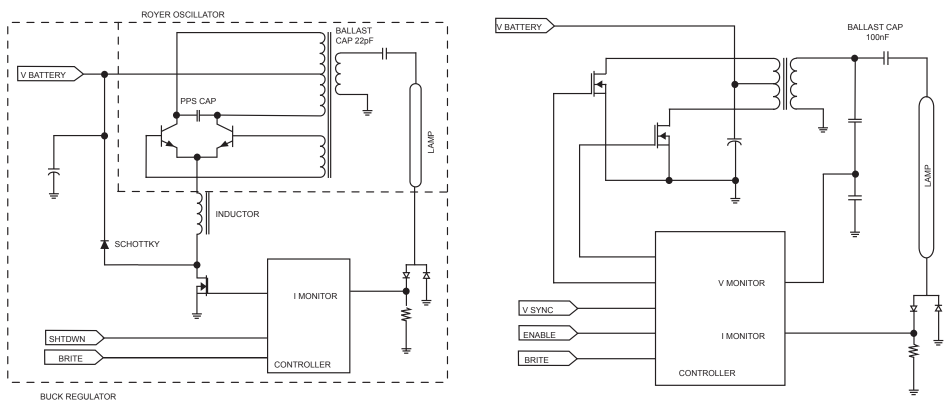


Figure 8.2: Buck Royer Oscillator versus Direct Drive

After we found most of the information we ordered samples of both the Direct Drive and one of the Buck Royer controller IC's and started to work on the actual design for the inverter that met the specifications of the assignment. We did this for both controller methods and documented how the IC's worked and how all the values of the used components could be determined to make the inverter match the required specifications.

We also looked how to measure if the inverter meets the required standards. We found that to knowing what each standard meant was not too hard, but finding out what the requirements for each standard meant, we would have to buy the documentation at prices of up to 200 dollars per standard. With almost 15 standards this became too expensive and was no longer required.

After fully documenting the design process we ordered all the components needed to make the direct drive inverter. After a rather tough time soldering the chip onto the board, since the chip had 10 pins on each side and was just 8 millimeters long, we finished building the design. For the Buck Royer oscillator we did not have to solder a complete inverter since Tieman also provided us with a test inverter which was usable for 2 CCFL lamps but just not completely up to specifications. The used transformers where not capable of delivering the amount of power needed by the lamps so one of the transformers burned out. After finishing the direct drive inverter we sent both inverters to Tieman together with the documentation.

8.10 Strukton Railinfra

Strukton Railinfra

Department:	Strukton Systems
Website:	http://www.struktonrailinfra.nl
Participants:	Jasper Klewer Dirk van Schaijk
Project:	**POSS**

8.10.1 About Strukton Systems

The company selected for us to do our contact research was Strukton Systems bv, one of the corporate divisions of Strukton Railinfra. Strukton Railinfra is part of Strukton, an important player operating in the construction market.

Strukton Railinfra is responsible for railway maintenance and renewal, with a focus on repair and technical installation. Strukton Systems focuses on power supply, passenger information systems, and safety and electrical systems in rolling stock. Working closely together with Strukton Railnifra's service departments, Strukton Systems is in a position to offer complete solutions - from concept up to and including the delivery and maintenance of systems that are ready for use. Strukton Systems has 250 employees and offices in Hengelo and Utrecht (the Netherlands) and in Aachen (Germany).

8.10.2 POSS

Passengers and the authorities are making increasing demands on the quality of public transport. Delays are no longer being accepted. Guaranteeing rail availability is more important than ever before. In this context, the responsibilities are shifting from the owner of the track to transport companies and process contractors. Fines as a result of delays are to be expected. Track objects, such as points, that are not functioning properly are no longer acceptable. Strukton Railinfra, equipping itself to deal pro actively with this trend, has developed the POSS monitoring system, that predicts faults before they actually occur.

POSS (the Dutch abbreviation of Preventive Maintenance and Fault Diagnosis System of Strukton) is part of a total concept to support and improve the maintenance process. The POSS system takes remotely controlled measurements and sends the results via the Internet to a central control center in order to inform service personnel. The resulting measures prevent faults and therefore delays. One of the main advantages of the POSS system is that the ageing of items is continuously being monitored. As a result, necessary maintenance can be accurately predicted and scheduled, thus reducing costs.

Important characteristics of POSS include:

- No interference with existing systems;
- All items are linked;
- Central monitoring/control;
- Easy to install;
- Open standard.

POSS is accessible via the Internet, allowing experts to assess the situation from any given place. This results in online monitoring and immediate response in the form of necessary measures.

Other applications of POSS include: monitoring of the condition of rails, points heating, train detection and civil objects; easy connection of critical bridges, tunnels and level crossing system components; application of web cams.

The POSS system has been rolled out over more than 1,000 points in the Netherlands and is currently being installed for the monitoring of points heating.

The subject of the contract research was to improve the POSS system by providing it with mathematical supplements. The nature of these improvements is classified.

8.10.3 Working environment

Although the research was carried out at home, the visits at the Hengelo and Utrecht offices provided us with a positive impression of the amicable atmosphere of Strukton Systems. Although the mother company of Strukton is quite massive, Strukton Systems is a young and dynamic company. Because all the railway activities used to be carried out by the government institution of the DutchRailways (NS), the people working in different divisions in this area of expertise still maintain their professional network. This helps the communication within the company.

Internships and such projects mainly focus on the areas of mechanical, computer, civil and electrical engineering. The activities will have a direct practical link with the fieldwork. Initiatives of employees are encouraged and supported within Strukton Systems. Although the total number of people in Strukton Systems is 250, projects are carried out in relatively small groups. The employees have different backgrounds and are generally in their thirties. Most have enjoyed an academic or professional education.

Although the luxurious coffee machines and modern facilities are impressive, it was the working environment and atmosphere that really convinced us of the great opportunities that Strukton Systems can offer young academics.

8.11 Texas Instruments

Department: Design Engineering Department (Chemical sensors)

Website: `http://www.ti.com`

Participant: Martin Schepers

Project: **HVAC**

8.11.1 About TI

TI is a company known by a lot of people from the hand calculators. In reality, this is just a small part of the activities. TI is the world leader in digital signal processing and analog technologies, the semiconductor engines of the Internet age. Besides in digital signal processing, that is part of TI's semiconductor division, TI is also a very big player in the market for automotive sensors. These activities are carried out in the Sensors and Controls division with its European business unit located in Almelo. Other business units are located in the US and Japan.

The design engineering department of TI Almelo is divided in two parts: a physical sensor part, where pressure sensors are developed, and a chemical sensor part, where the focus is on gas sensors. In all, around 60 design engineers and technicians work at TI Almelo.

8.11.2 Project description

This research project has been carried out in chemical sensors part of the design engineering department. An important project here is the Air Classification Module (ACM), which can sense harmful gasses in the air outside the car. The output signal of this sensor is used by the electronic climate control of the car to close the recirculation valve to prevent polluted air or bad smells from entering the passenger cabin.

During this research a bond graph model of the heat flow and temperature distribution in the sensor has been developed. The results will be used to further optimize the sensor performance.

8.11.3 Working environment

The working climate at TI in Almelo is very pleasant, the people are very interested in what you are doing. Almost everyone from the group I was working in came for a little talk to get to know each other a little. The employees differ in age between 25 and 50 years, but the majority is between 30 and 40.

The knowledge level at TI in Almelo is quite high. Almost all employees have graduated from higher education of university. Most design engineers in the team I have been part of have a PhD degree. There are a lot of informal conversations when the engineers talk about the projects they are working on trying to find some solutions together.

Over the last years TI has created quite some vacancies for graduated students each year, either from higher education or university. Most vacancies are suitable for mechanical and electrical engineering students. Furthermore there are a lot of opportunities for a training period or a graduation assignment.

8.12 Thales Nederland

THALES

Department:	JRS-TU Mechanics
Website:	`http://www.thales-nederland.nl`
Participant:	Bart Spikker Thomas Janson
Project:	**Active Phased Array Antenna Unit**

8.12.1 About Thales

In the period between the 24th of May and 1 July, we did our contract research for the Shouraizou studytour at Thales Nederland in Hengelo. Thales Nederland is part of the Thales Group, originating from the Thomson-CSF Group. In 1990 Thomson-CSF incorporated Thales Nederland, at that time known as Signaal. The Thomson-CSF group renamed itself in 2000 to Thales Group and, being a member of this group, Thomson-CSF Signaal changed its name to Thales Nederland.

Thales Nederland is specialised in designing and producing integrated systems for command & control, surveillance, weapon control and communication purposes. The company has two branches in defence systems, being Thales Naval and Thales Ground Based. The product range of Thales Naval Nederland comprises systems suitable for all classes and types of naval vessels, any weapon system and any mission. Modern and highly capable sensor suites, together with the combat management system TACTICOS, equip new generations of frigates, corvettes and fast attack craft throughout the world. Naval capabilities of Thales include sophisticated Anti-Air Warfare systems, featuring APAR, SMART-L and SIRIUS.

The headquarters settled in Hengelo has its own Research & Development division in Delft in the areas of radar technology and radar systems. Thales Nederland knows besides three Germans settlements a few settlements more. One is Thales Communication, settled in Huizen. They are basically active in communication system and networks for military-, naval-, and civil applications. Second, Thales Cryogenics and Thales Munitronics, both settled in Eindhoven. They are working on the development and manufacturing of cooling systems, batteries and (ammunition) fuzes. Thales Optronics in The Hague is the last settlement. Optronics combines optics, electronics, sensors, highly sophisticated image processing algorithms and software to provide real-time imaging at any time of day or night in almost any weather conditions. So they develop and manufacture for example IR-camera's.

8.12.2 Project description

For our contract research we worked on the Active Phased Array Antenna, which is part of the APAR system. APAR is an I-band Active Phased Array Radar providing the multifunction capabilities required for the modern missile threat. This includes target detection, tracking and multiple missile control based on mid-course guidance and terminal homing. The complete APAR multifunction radar consists of 4 faces covering 360 degrees of possible threat. Information about the actual research for Thales will not be given, since it has been marked as classified. This awareness of the necessity of high-level security is present at all levels at Thales, which is a logical consequence of the type of products that are being developed. A negative effect of this high security level we experienced is slow-down in internal communication, which results in reduced speed of innovation.

8.12.3 Working environment

The work at Thales is on a high-tech level with multi-disciplinary experts. Thales offers competitive terms of employment, early responsibility, first-class training, plenty of teamwork and the recognition and development opportunities you deserve. You will be given the opportunity to gain insight into a different culture and ways of doing business while enhancing both your technical and linguistic abilities. Your resume will be highly appreciated when you return. It is very likely that you will be offered and attractive position with Thales in your home country. Or you could take on another foreign assignment, should you prefer this.

8.13 University of Twente - ICD

University of Twente
The Netherlands

8.13.1 About ICD

Two contract researches were conducted at the chair ICD at the University of Twente. ICD stands for Integrated Circuit Design. ICD is an electrical engineering chair of the faculty for Electrical Engineering, Mathematics and Computer Sciencs (EEMCS) of the University of Twente. The main subject of their education and research program is the design of integrated circuits, with a focus on CMOS Transceivers.

IC's are at the heart of recent developments in mobile telecommunications, multimedia and internet, and in numerous other applications. IC design is of large industrial importance, which is even truer for analogue circuit design, in which the European electronics industry has a leading position. In the Integrated Circuit Design group (ICD-group) research is done on integrated transceivers in CMOS technology. This includes transmitters and receivers for wireless (GSM, DECT, satellite, etc.) and wireline (subscriber line, cable modems, fibre) communication systems. The main goal for ICD is to develop clever IC design techniques to realise more portable and faster communication systems at a low cost. Current projects that are running at ICD are in the field of AD converters, frequency synthesisers, Radio front ends, noise reduction and fibre-optic interfaces. These challenges in high-frequency analogue and mixed-signal circuit design are addressed in close cooperation with the industry, in order to find fundamental solutions for practical problems.

ICD also contributes in the area of education. Numerous different subjects like ELBAS (Electronic Base Circuits), ELFUN (Electronic Functions) and ESP (Embedded signal Processing). Due to many contacts and research contracts with industry, and the part-time position of some staff members in industry, the industrial relevance of the research program and the knowledge transfer is high.

A career at ICD

Bachelor students who choose for either Microsystems & Microelectronics (MM) or Embedded Systems (ES) will participate in courses in IC design, guided by members of ICD. After the five years EE program, students with a M.Sc. degree in EE with excellent results can react on a vacancy to become a PhD student. The PhD degree is received after 4 years and there are many national and international job opportunities for highly qualified doctors from ICD.

8.13.2 Project 1: Phantom oscillator

Department:	Integrated Circuit Design (ICD)
Website:	http://www.icd.el.utwente.nl
Participant:	Harald Profijt
Project:	**The Phantom Oscillator**

For the third college year of the study Electrical Engineering (EE), an Individual Research (IR) assignment is planned. In eight weeks, a student will solitarily perform research at a chair of Electrical Engineering. Because I planned to start with my IR assignment after the summer holidays, I gratefully accepted Shouraizou's offer to perform it at the Integrated Circuit Design (ICD) chair as a contract research.

Project description

There are different ways to convert a radio signal to a data signal at a usable frequency. One of these ways is by using a direct conversion receiver architecture, where the incoming radio frequency (RF) signal is direct-converted to the frequency band (base band) at which we want the signal to be. It is very important for the quality of the output signal that this operation is performed at high precision.

A mixer is a component that can be used for frequency-shifting a RF-signal to base band. The operation is performed by multiplying the RF-signal with a local oscillator (LO) signal. Figure 8.3 mathematically explains how this 'shift by multiplying' operation works.

$$
\begin{aligned}
x_{in} &= A_1\ sin(2\pi f_1 t) \\
LO &= A_{LO}\ sin(2\pi f_{LO} t) \\
Y_{out} &= x_{in} \cdot LO \\
\\
Y_{out} &= A_1 A_{LO} sin(2\pi f_1 t) sin(2\pi f_{LO} t) \\
&= \frac{A_1 A_{LO}}{2} sin(2\pi(f_1 - f_{LO} t) + \frac{A_1 A_{LO}}{2} sin(2\pi(f_1 + f_{LO} t)
\end{aligned}
$$

Figure 8.3: Explanation of the 'shift by multiplying' operation

Good mixers are hard to build physically, especially when they have to operate at high frequencies. In a phantom oscillator architecture, multiple mixers are used to design a system that behaves like one mixer. Scientists claim it will introduce improvements in DC offset, IIP2 (second order) noise and LO (local oscillator) radiation.

Improvement in DC offset is important because this offset makes it hard to detect near-zero frequency components. The reason can be found in the fact that the DC offset amplitude often is much higher than the near-zero information component's amplitude. We also want to avoid IIP2 noise, because it introduces a non-linearity that affects the output signal we want to be linearly multiplied. Finally, LO radiation has to be avoided, because this is one of the ways in which DC offset is generated. It especially occurs at higher frequencies because then impedances of parasitic capacitances of transistors are low and better conduction between their different terminals will be realized.

In figure 8.4 the principle is demonstrated by two mixers (left on top in the figure) that behaves like one (right on top in the figure).

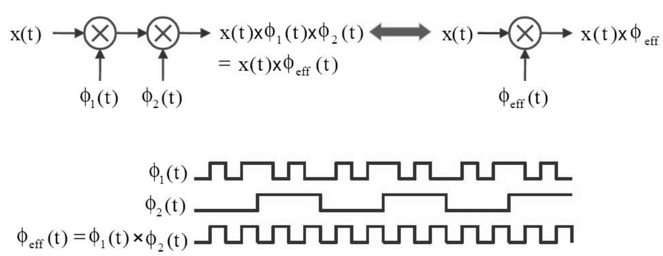


Figure 8.4: The idea behind the phantom oscillator

In the figure, the dual mixer system uses LO-signals 1 and 2, when they are multiplied an effective LO signal eff is obtained. When using a phantom oscillator design, down conversion can be performed in multiple steps. According to scientists it will result in various advantages like improvement in reduction of DC offset, IIP2-noise and LO-radiation.

The IOO assignment was to verify and quantify these advantages by performing simulations in MATLAB using practically a-periodic signals.

Experiences

I experienced the atmosphere at ICD as very positive. Whenever I had questions, I could easily get answers to them. In my opinion the chair deals with very interesting research topics.

8.13.3 Project 2: Laboratory assignment

Department: Integrated Circuit Design (ICD)

Website: `http://www.icd.el.utwente.nl`

Participant: Jos Ansink

Project: **Laboratory Assignment**

Project description

The conducted contract research was aimed at the field of mobile telecommunications. The contract research was part of a larger research in which designing and testing high frequency signal amplifiers for mobile telecommunications is the central research topic.

To be able to see if the realized circuit has the desired response, a simulation has to be made. To be able to simulate high frequency signal amplifiers, so called S-parameters have to be known. These are comparable with the transfer function of a high frequency amplifier. The S-parameters are used instead of the transfer function because of the non-linearity of high frequency amplifiers.

To obtain these S-parameters, measurements have to be made. My research assignment was to create an interface between a frequency generator, a spectrum analyzer and an oscilloscope, from which the S-parameters can be determined. A measurement setup to determine the S-parameters is given in figure 8.5.

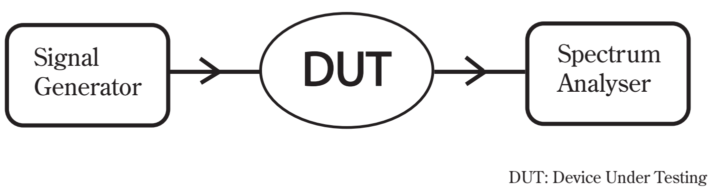


Figure 8.5: Measurement setup

The DUT is the high frequency amplifier from witch the S-parameters have to be attained. The interface has to be created in a program called APLAC. This is a program which is suitable to make analysis on high frequency electronics. APLAC is comparable to PSPICE with the difference that APLAC can communicate with measurement equipment and is meant for high frequency electronics. The aim of he contact research was to create the basic interfaces between APLAC and the measurement equipment stated above. Only the function generator and spectrum analyzer where available at the time. These two devices were installed and modeled in APLAC to conduct different measurements like a peak search, signal to noise ratios at different frequencies, ect.

8.14 University of Twente - MI

University of Twente
The Netherlands

Department:	Laboratory for Measurements & Instrumentation (MI)
Website:	`http://www.mi.utwente.nl`
Participant:	Michel Franken
Project:	**Development of a State Predictor**

8.14.1 About MI

The laboratory for Measurements & Instrumentation (MI) is a department of the faculty of EWI (Electrical Engineering, Mathematics and Informatics) of the University of Twente. This department provides courses to electrical engineering students and also to students of other departments. Besides these courses also research projects are provided to students. These research projects are based on or derived from the research topics with which the researchers are involved. Besides providing an educational program in measurements the staff of MI focuses on the study of the science of metrology and brings that acquired knowledge into practice.

The research activities of MI concentrate on the two main phases in an information acquisition process. These two phases are signal acquisition and signal processing. Signal acquisition is the transduction from a physical quantity to an electrical signal. Signal processing is the extraction of the essential information from the acquired data. The main application areas that are covered by the various research projects are mechatronics and robotics, navigation and traffic, security and safety, industrial inspection and tools for disabled people.

The permanent staff of MI consists of a scientific staff of four people, a technical staff of two persons and one secretary. Besides the permanent staff there are also four temporary staff members. These temporary staff members are doing a large research project at MI in order to obtain their PhD. Work possibilities within MI for graduated students are mostly limited to PhD positions

8.14.2 Project description

My assignment was part of a research project obtained from the industry. A company in Germany employed MI to analyze a problem they were facing in the development of their product and to let them come up with possible solutions for this problem. The goal of my assignment was to develop and evaluate a method for the prediction of future states of a dynamic system using measurements of these states. First of all the dynamic system was analyzed and a model was constructed. After this model had been constructed a state prediction algorithm was programmed in Matlab. This algorithm incorporated an extended Kalman filter which is an integral part of optimal estimation theory. The results of this algorithm and its properties were then analyzed and examined, like the maximum prediction lead by a given certain maximum tolerable deviation.

8.14.3 Experiences

In short MI is a place where a lot of knowledge about measurement systems is present and the research projects performed at MI are at a highly academic level and aim to provide new measurement technologies that add new possibilities to industrial processes and products.

8.15 University of Twente - SMI

University of Twente
The Netherlands

Two participants have been working on two projects for the chair of Systems and Materials for Information Storage of the University of Twente. First this chair will be introduced. Then each project will be discussed separately.

8.15.1 About SMI

Systems and Materials for Information Storage (SMI) is an Electrical Engineering chair of the faculty for Electrical Engineering, Mathematics and Computer Science (EEMCS) at the University of Twente. Their office is located on the 6th floor of the Hogekamp building at the university's campus. The group consists of 40 people (11 students) working on several subjects in materials, devices and systems for information storage. There is no real hierarchy, officially one person (dr. ir. L. Abelmann) is the acting chairholder, but in practice all members are treated equal.

A career at SMI

Usually the work at SMI will exist of doing research in the materials, devices and systems area. As a student you can do this during practical assignments, as group projects, the individual project or your grand finale research project. After that one can join the ranks and become a dedicated researcher on a daily basis, eventually becoming head of the chair. But that will be quite a long term project on itself.

8.15.2 Project 1: Open Reference

Department:	Systems and Materials for Information Storage (SMI)
Website:	`http://www.el.utwente.nl/smi/`
Participant:	Eelco Dalhuisen
Project:	**OpenReference**

Project description

The assignment itself was an idea of dr. ir. Abelmann and Klaus Ramstock. For the work people do, they need a lot of information (be it (digital) books, papers, journals or other kinds) and on a regular basis papers like those are requested from external sources. Since many people more or less all work in the same research area, any piece of information will be useful for more than one person. However, there was no way to keep track of all the requests done and a lot of papers got requested twice or not ordered at all, which resulted again in unnecessary waiting and possibly extra costs. OpenReference, originally thought up in 2000, has seen an original instance from Klaus Ramstock, a remake in 2001, and finally another in 2004 by me. It should be able to provide all users with a common database of references for searching, downloading and requesting, and allow each user to maintain a personal index. Also, OpenReference is completely open source.

Experiences

Since this was a programming assignment I have done most of the work at home. However, the few times I was at location it was a pleasant office to be. In case of need everyone will make time for you and/or have a little chat and there is always interest in other peoples work. The kind of work I did was creating a utility to help with the work being done, and other jobs like this will be incidental at best.

Even though the contract research is officially over, I will stay with SMI for the purpose of fine-tuning OpenReference in case of bugs, features or support.

8.15.3 Project 2: Anomalous Hall Effect

Department:	Systems and Materials for Information Storage (SMI)
Website:	`http://www.el.utwente.nl/smi/`
Participant:	Mathijs Marsman
Project:	**Anomalous Hall Effect** Investigation of nanoscale magnetic structures

Project description

In April I started my contract research in connection with the IOO assignment. Consequently the total research project took eight weeks. The assignment was about the investigation of magnetic properties of very small (100 nm) magnetic dots by using the so-called Anomalous Hall Effect (AHE). With this we measure the AHE voltage as a function of the perpendicular applied magnetic field to the sample. The assignment consists of three parts: improvement of the measurement set-up, measurement and analysis, and modeling of the current flow in AHE samples. The set-up is modified and now it is possible to carry out angular dependent measurement and moreover the noise level is also improved.

In the angular dependence measurement, it is clearly shown that the switching of the magnetization originates from small nuclei in the magnetic dots. The current flow simulation is carried out by using finite element method in order to study the sensitivity of AHE measurement. From the result, it is concluded that the sensitivity of the AHE measurement depends on the areal ratio of dots against electrode. The result suggests that the AHE method has potential to detect switching of a magnetic particle of 10 nm in diameter. The result obtained in this project with the AHE measurement is also useful for a scanning probe-recording project that is carried out also by the SMI-group.

Experiences

Working for eight weeks at SMI I got a good picture of the work climate. The atmosphere is good. The breaks are pleasant. Everyone is interested in each other's work and visits the weekly group presentation on Thursdays. The technical staffs are ready to help. This motivates everyone to his or her work well.

I have had a nice time at SMI. My assignment had all the aspect of electrical engineering: modeling, soldering, measuring and data analyzing. I do not know yet if I am going to do my master at SMI.

8.16 Versatel Nederland

Several participants have been working on three projects for Versatel Nederland B.V. First Versatel will be introduced. Then each project will be discussed separately.

8.16.1 About Versatel

Versatel is an ambitious telecommunications company on the Dutch, Belgian and German market. The company has an extensive product portfolio of fixed telephony, data, internet and recently mobile telephony products. Versatel was founded in 1995. Today Versatel is a mature company with more than 1,700 employees and over 1 million customers. Versatel (VRSA) is publicly traded at Euronext Amsterdam and part of the AEX-index as of March 2, 2004. Currently, Versatel is a leading alternative for the former monopoly telecommunication carriers in its target markets of the Benelux and Germany.

The products and services of Versatel Nederland B.V. focus on both large companies as well as the SME-market. Versatel has an asset that most other operators of fixed telephony do not have; it owns an extensive DSL- and fiber optic network. This is an advantage that allows Versatel to offer a complete package of services to the business and residential market: from a subscription for telephony and super fast internet to innovative and fully managed data solutions.

In addition to the core activity of providing broadband telecommunication services to business customers, Versatel founded Zon, an Internet Service Provider that plays an important role in the growing market of residential Internet services in the Netherlands.

8.16.2 Organization

The technical organization of Versatel is divided in several groups.

- The *innovations* department, which examines new network technology to see if it is interesting to add these to the existing portfolio.
- The *development* group prepares the new technology and components to be applied in the network as a product.
- The *planning* department decides exactly where, when and how many network elements should be placed. In addition, they also reserve the budgets for the projects.
- The *build* department is in charge of the actual placement of the network elements.

- The *operations* department, which maintains and monitors the network. Versatel has it's own network Operations Center, from where the network is remotely monitored and controlled. The network elements are closely monitored, for example for power failures, line failures, equipment failure, etc.

8.16.3 Job perspective

Versatel is a young organisation with an average age of it's employees of about 32 years. Versatel is ambitious and tries to achieve perfection in delivering products, services and facilities to its customers. Employees are a very important part of the chain within this and that is why Versatel grants great value to education and 'training on the job'. Versatel's employees are active in a wide range of functions within the departments of Versatel, varying from Sales to Marketing and from Operations to Customer Support.

Working at Versatel is working at the dynamic and hectic telecommunication industry. Development goes on high speed, which implies hard working. Despite that, there is a very informal work atmosphere with enthusiastic and driven colleagues.

8.16.4 Project 1: CBDB

Department:	Transport Development
Website:	`http://www.versatel.nl`
Participant:	Paul Omta
Project:	**CBDB**

Project description

My assignment was to solve a problem Versatel had. A major node in the Versatel network is called a PoP (Point of Presence). Here big glassfiber cables are multiplexed in different lines with smaller bandwith. For the sake of redundancy, the multiplexers have 2 supply lines. In principle, if one of the power lines would fail, the other one would take over. Some implementations of this principle are not entirely spotless. At a few locations, it is the case that if the redundant power line would fail, the operator sometimes would not get an alarm. It was my job to accurately determine why this happens sometimes at some PoP's, and to suggest a solution.

I succeeded in finding the source of the problem and eliminating it with an easy solution. The manager of my supervisor was very pleased with my work.

Experiences

Versatel was a nice company to work at. I was able to work 'in house' at the Versatel main office in Amsterdam. The image I got from the work atmosphere and culture was good. Versatel has an open structure, so no office cubicles. Everyone of a department has their desks in one room, making it easy to communicate. The people working at Versatel are very helpful. They will always make a little time to answer questions. Versatel is a very young company, so there are very few to no people above 50. Most employees are around 30. This is the reason that the culture at Versatel is quite informal and relaxed. As an employee you can decide when to come and when to leave your work. As long as you get the job done. Most employees in the *development* department have an HBO or academic degree.

If a student electrical engineering would want a job at Versatel, there are possibilities in *development* and *engineering*.

8.16.5 Project 2: ESD

Department:	Transport Development
Website:	`http://www.versatel.nl`
Participants:	Bertjan Davelaar Laurens van Oostveen
Project:	**ESD**

Project description

The contract research that was done at Versatel involved Electrostatic Discharge (ESD). To many people, static electricity is little more than the shock experienced when touching a metal doorknob after walking across a carpeted room or sliding across a car seat. However, static electricity has been a serious industrial problem for centuries. The age of electronics brought with it new problems associated with static electricity and electrostatic discharge. And, as electronic devices became faster and smaller, their sensitivity to ESD increased. Today, ESD impacts productivity and product reliability in virtually every aspect of today's electronics environment. Industry experts have estimated the actual cost of ESD damage to the electronics industry as running into the billions of dollars annually.

For a high-tech company like Versatel it is important to reduce the consequences of ESD and to prevent ESD to a minimum. The assignment was to write a consultancy report on how to reduce ESD to a further minimum at Versatel. By visiting a few of Versatel's network nodes to get insight in the current situation and compare this to ESD standards across the world, a report was written to give measures and guidelines to further improve Versatel's ESD policy.

The red line through ESD policy, is the idea that everybody and everything in an ESD safe area by determined maximum resistancy is connected to a common ground. By this principle, it is always guaranteed that ESD is prevented because charge can not be build up and constantly flows a way to the ground.

The contract research has been finished successfully for everyone involved. The final report is received very well by Versatel, the assignment was interesting and we have learned a lot and the contact with the Shouraizou organization was effective.

8.16.6 Project 3: MDF

Department:	Transport Development
Website:	`http://www.versatel.nl`
Participants:	Janarthanan Sundaram Casper van Benthem
Project:	**MDF**

Project description

To guarantee the continuity of the telecommunication services provided by Versatel, network operators are immediately notified of any equipment failures in their network, so faulty equipment can quickly be replaced. Aside from equipment failure, operators must learn of hazards such as power failure, overheat and burglary as soon as possible. We had to conduct the process to select a system that could monitor these influences, possibly replacing current cabinet control equipment.

First, we had to determine the requirements for a new monitoring system. There appeared to be various possibilities for implementing such a system, and we have identified the advantages and disadvantages of the options. It was obvious that the system had to send an alarm to notify the operations center, and this can be done using the existing interface on the network equipment, or an Ethernet connection. Temperature, humidity and unauthorized access have to be monitored. In some cases, an existing Cabinet Control Unit had to be replaced, so cooling fans also have to be controlled and monitored.

We have been looking for equipment that is suitable to do all this. Several manufacturers have been contacted about the monitoring equipment they make, and we have made several inquiries for pricing and options. Some manufacturers offered extensive customization of their monitoring systems. We have put down our findings in a report, documenting our recommendation. After presenting our findings, Versatel decided to continue in line with our recommendation.

Working environment

When we were working with our supervisor in this project, we were on a large working floor in the Versatel headquarters. On this floor, people from various divisions such as *innovation*, *Development* and *Purchasing* had their desk and computer. It was interesting to see that there was a lot of communication between the people of different divisions. Versatel has a clear scheme for how plans, for instance for new products, should formally be accepted and passed on to other divisions. In combination with the less formal way of communication, it seems likely that plans can be made very efficiently.

Over all, the atmosphere in Versatel seems good. For what we have seen, people are genuinely friendly and helpful to each other. Overall it seems like a nice place to work.

Chapter 9

Cultural activities

Traveling is all about preparation. Although people say that you can get anywhere when you have your passport and credit card with you, we believe that preparing yourself on the culture and places you are going to visit will definitely take you further. You will be able to see and experience more if you know where to look and if you understand what you may see.

That is the reason why the Shouraizou committee organized an extensive Japanese language course, a film night and a Japanese dinner. These activities were described in the preliminary report. Before stepping on the plane to Japan, the participants and some of the supervisors took part in one more cultural activity: a symposium on Japan!

9.1 Japan symposium

by Martin Schepers

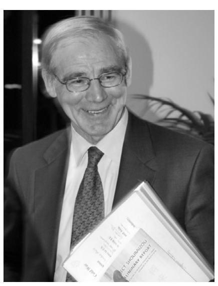
In the past, the influence of China on Japan was rather large. This is explained by the large number of Buddhist temples, but also by Confucianism. Without some knowledge about this philosophy of life, Japan is hard to understand. In order to get some insight in the backgrounds of Japan as well as to get a vision on the future, a symposium at the University of Twente was organized, in cooperation with Studium Generale. The central question during this symposium was: “What will be the future of Japan and what is the role of technological innovation in this?”

Two professors gave a lecture. The symposium started with a lecture of Prof. Dr. W.J. Boot about Japan and (neo)Confucianism. He is professor Language and Culture at the University of Leiden. The second lecture was given by Prof. Dr. J.A. Stam and it was about technological innovation in Japan. He is special professor at the Erasmus University as well as the University of Twente and he investigates management and technological innovation in Japanese business.

Professor Boot focused in his lecture on four main points, being the social organization on micro scale, the social organization on macro scale, the relations with foreign countries and religion. During his lecture it became clear that China always has had a large influence on Japan. One of the results is of this influence is the existence of Confucianism in Japan. Within Confucianism emphasis is on rituals and 'good behavior'. Later on, the influence of China decreased, while the United States became more and more important. Due to these large influences, the relation of Japan with foreign countries has always been asymmetric. Japan has always been at a lower level compared to first China, and later on the United States.

The lecture of Professor Stam was about the influence of political and economical factors in Japan and the role of technological innovation. One of the points he mentioned was about the efforts of Japan to rebuild the economy after the 'burst of the economic bubble'. Over the years it became clear that other countries were catching up with Japanese technology. To overcome this, Japan started to reposition the Japanese industry, for instance by active alliance building with foreign partners. A nice example is the alliance between Nissan and Renault. Nissan has always had a large share in most of the suppliers. As a consequence, Nissan always had to use these suppliers for their parts and there was no rivalry. From the moment Renault became a major shareholder of Nissan, over one half of these shares were sold. This meant Nissan was able to choose the cheapest supplier and due to rivalry the prices lowered, which caused Nissan to grow.

To overcome the time between the lectures and to fill the empty stomachs of the participants, Shouraizou organized a Chinese meal. During this meal four supervisors, who would travel to Japan with us, introduced themselves to the participants. They all had some nice experiences to share and were all looking forward to the study tour.



(a) Prof. Stam

(b) The audience

(c) Prof. Boot

Figure 9.1: Japan symposium

Epilogue

When we first came together as organizing committee almost 2 years ago, we started with the idea of organizing a study tour. As time passed by, this idea grew into one of the biggest study projects in the history of the University of Twente.

Looking back, we can only say that we are very proud of what we have achieved with student participants, supervisors, board of recommendation, advisors and friends, companies, universities, institutes and other organizations both in the Netherlands and Japan. We thank them all!

We hope that you have enjoyed reading this final report. Hopefully, our experiences and research results will prove valuable to you. For sure we have learned a lot. The study project Shouraizou is something we will never forget!

Enschede, March 2005

Bayan Babakhani
Siebe Berveling
Arjen Damstra
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Roland Meijerink
Erik Staijen
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Where can I find ... ?