DeMaMech Program Report

Osaka University

Takamasa Matsumoto

Personal data

Name: Takamasa Matsumoto

E-mail: takamasa@jwri.osaka-u.ac.jp

Home institute: Osaka University

Department of Mechanical Engineering

Naka Shibayanagi Laboratory

Address: Mihogaoka 11-1, Ibaraki, Osaka, 565-0871, Japan

Supervisor: Ass. Prof. Toshiya Shibayanagi

Host Institute: Technical University of Berlin

Department: Faculty of Mechanical Engineering and Transport System, Institute for Machine Tools and Factory Management

Address: Pascalstrasse 8-9 D - 10587 Berlin

Supervisor: Prof. Dr. –Ing. Frank-Lothar Krause

Dipl. -Ing. Christian Kind

Host Institute: Technical University of Denmark

Department: Department of Manufacturing Engineering and Management, Institute of Product Development (IPU) Section

Address: DK-2800, Lyngby, Denmark

Supervisor: Prof. Peter Jacobson

1. Excusive summary

I studied in Berlin from September 2005 to December 2005 I was engaged in research work at Technical university of Berlin. My research topic was modeling and optimization of product development processes. I also took a course which was related to my research topic in Berlin. The title was systematic product development 1, but I could not take an exam. I only attended the course from the middle of October to the end of December.

I went to Denmark on January. I studied at Technical University of Denmark, and I took an intensive course for 3 weeks. The title was Laboratory Course in Process Simulation. In this lecture we studied metal casting, thermal contraction of metal product, injection moulding and bulk metal forming with simulation soft for example MAGMASOFT, SIGMASOFT and DEFORM.

I could have many good experiences in Europe. There were many students from all over the world. I described exchange student life in section 5. I mentioned Suggestion and Summary in section 6 and in sention 7 respectively.

2. Travel Schedule

Technical University of Berlin: From September to December 2005

Technical University of Denmark: January 2006

3. Technical report

4.1 Technical University of Berlin

4.1.1 Research: Modeling and Optimization of Product Development Processes

Introduction

Market and customer needs are changing quickly. Customers need individual product that are cheap and have high quality. In market there are low price and high quality products. Competing of product development becomes severe. These things compel company to optimize own product development process, for instance to reduce development time and cost and to improve product quality. Company has to adopt efficient product development process to survive. It is important to consider to product development process and optimize the process, and to model their development process is needed In order to optimize their product development process. There is various kind of process modeling method.

I focus on product development process, strategy of product optimization and process modeling method. I compare with Japanese and European development process and design process in it. Especially I consider Mechatronics design and integrated methodology. Finally I introduce the existing concept of development process modeling and analyze them.

Analysis of Product Development Process between European and Japanese

At first I focus on how to develop the product and whole process of product and I compared with European product development process with Japanese one.

European product development process by Mr. Krause is illustrated by Fig. 1 [4], Japanese one by Mr. Suzue is shown by Fig.2.

The two processes mean almost the same thing. There are some common understandings between the two. Product design include in both process. And the meaning of product test is similar to trial making. Product test and trial making are related action and we cannot separate them. Production process also correspond manufacturing preparation. They mean decision how to manufacture product.

There is also different point. Japanese process by Suzue doesn't have product research and product planning but I found that the other Japanese author wrote Product research and Product planning in product development process. He just does not focus on this point. Product specification sometime include in product design. However there is little different view by different author, there is no big different in whole process of product development between European and Japanese.

Analysis between the two design processes

The Japanese design process does not include product requirements, feasibility and specification process compared to European design process. These three processes are categorized in product specification or product planning phase in Japanese product development process. But there is no difference in the whole design flow. Japanese basic design corresponds to analysis and modeling process in the European point of view. The embodiment and optimization process in the European methodology are summarized in the detail design by Japanese point of view (see picture below).

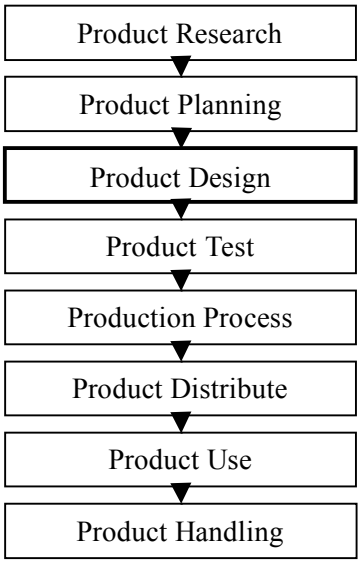


Figure 1 European product development Processes [4]

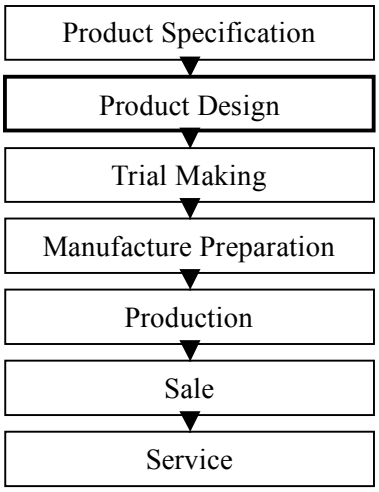


Figure 2 Japanese product development processes

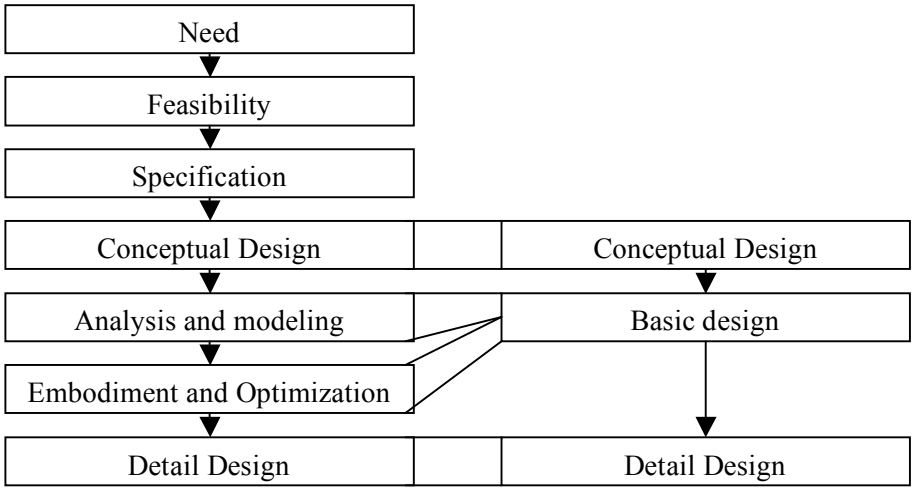


Figure 3 European design process Figure 4 Japanese design process

Methodology for Mechatronics Design

Mechatronics mainly consists of three different disciplines. The design and system development are difficult and complex. But generally speaking, each specialist realize only own field. It needs interdisciplinary technical Know-how and technological integration. I focus on design process for Mechatronics product.

V-cycle Model of the Design Processes

The whole design process of Mechatronics system be explained by V-cycle model described in Figure 5. The design process model is a combination between from top to down (design & development) and from bottom to top (Validation & test) process to realize customer requirements

and to reduce lead time and cost. This process is made up of three levels which are system requirements analysis, system design and Component design and development.

In the level of System requirements analysis, customer requirements are analyzed and whole product functionality is specified. Next, how to realize functional behavior is determined to satisfy system requirements specification in the level of system design. In the level of component design and development, each component is designed simultaneously. Mechatronics consists of different field. Different designers who have the different viewpoint are involved.

Each level of design methodology is illustrated in Figure 6. At first design process start from corresponding requirement specification and then different test cases are generated. Engineer develops and evaluate different concept, save possible ones and finally decide the design. Depending on the level of design process, the Model which are virtual prototype and physical prototype are made by the decision of the concrete design. Usually the design is tested and modified several times to fulfill the requirement specification before the final definition of the design. The recursions continue until the design meets the requirement specification.

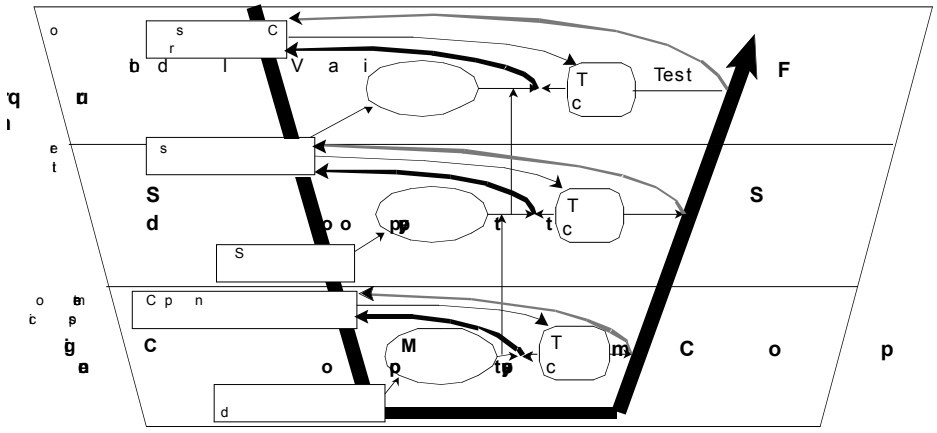


Fig 5 V-cycle for the design of Mechatronics systems (Moran, 2002)

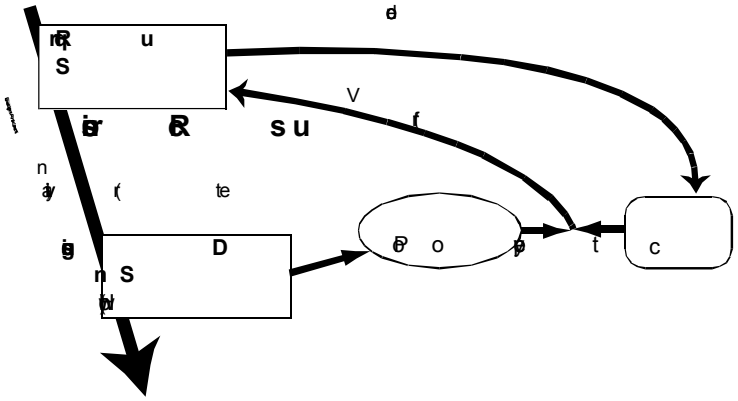


Fig 6 Design procedure within the different level of the V-cycle (Moran, 2002)

Evaluation and Analysis Development Process Modeling Method

In order to model product development process there are several process modeling method. Now I compare with feature of each modeling method (ARIS, IDEF, and Petri-net) for evaluation and analysis.

Each modeling method is principally used in different field. ARIS and IDEF are mainly utilized as business modeling method for improving business and support innovational activity as well as structuring the integrated information system. On the other hand Petri net is utilized not only for business process but also for modeling manufacturing system. Petri nets are used more for Engineering.

In hierarchical point of view, ARIS and IDEF have hierarchic structure. Since IDEF is versatile describing method, what you should describe is not decided in each hierarchy.

But Petri nets also have problem. Low level Petri net does not have hierarchical structure and encapsulation. So Petri net model become quite large.

IDEF0 is function modeling tool for describing static system. But IDEF also has tool which is dynamic modeling tool. IDEF2 supports to describe dynamic system. Petri net also help to describe dynamic system,

Conclusions

I present product development process, and development process modeling methods. Especially I focus on Product design process and methodology for Mechatronics products design in product development process. European development process almost corresponds to Japanese one in point of basic structure and flow. The two is also the same about Product design. Mechatronics consists of three main fields. As Design methodology and object which Engineers design are different in each field, company has to consider to integrate each field and to communicate with each engineer. It is also necessary to optimize process to reduce cost and lead time and to improve product quality. Finally I introduce and compare with three process modeling methods which are ARIS, IDEF, and Petri net.

Future work

Future work is to make idea of new concept for software supporting the modeling and optimization of product development process, and to decide the specification of that. Analysis and evaluation has to be done.

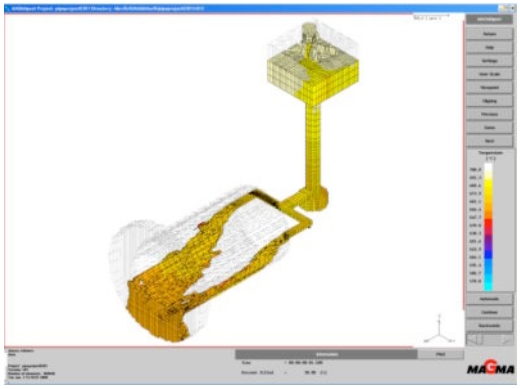
4.2 Technical University of Denmark

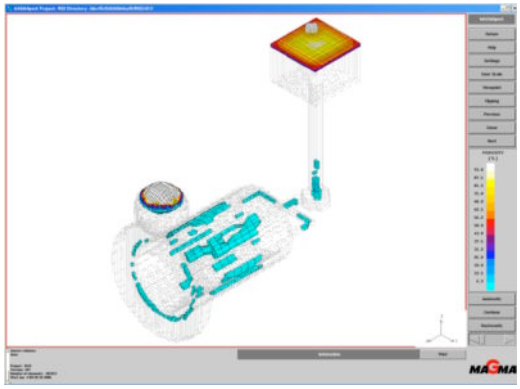
4.2.1 Lecture

In this lecture we studied metal casting, thermal contraction of metal product, injection moulding and bulk metal forming with simulation soft for example MAGMASOFT, SIGMASOFT and DEFORM. At first we have lecture in this course. After that, I began the exercise. I was engaged in exercise almost time in this course.

Casting a pipe with a flange: Design of gating system and feeding

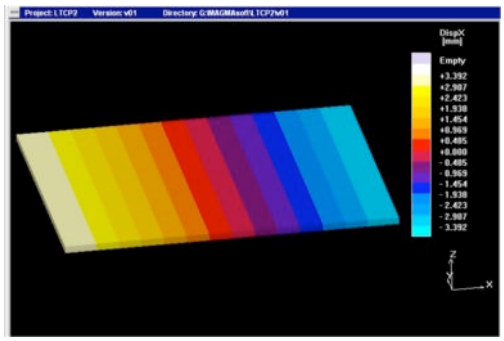
I used MAGMASOFT to consider about metal casting for making pipe with a flange. I calculated size of feeder and put it on for reducing porosities. Next we changed the material and analyzed the difference (for example the amount of porosities). Gating system are also designed and put. We make change to improve the temperature gradient in the casting and discuss about how casting solidify and the number of porosities.

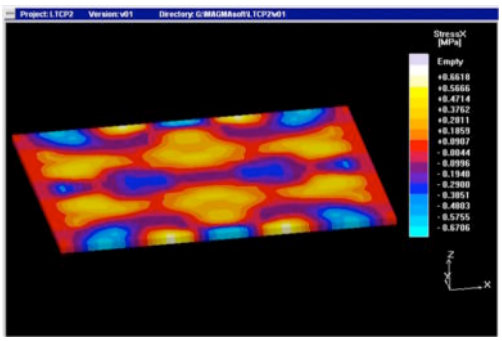




Linear thermal contraction of a plate

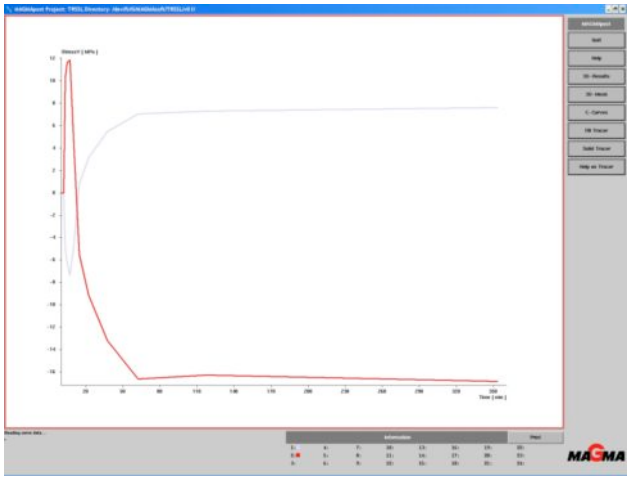
I analyzed the linear contraction of a steel and Alminium plate with MAGMASOFT. At first I consider about thermal contraction in the situation of free plate. I compared value of contraction, stress and strain that is calculated by analytical calculation with numerical simulation. we compared difference between Steel and Alminium. Next I consider about the plate with mechanical constrain in the x- direction and in both x- and y- direction. And we also compared analytical calculation with numerical simulation, and difference between steel and Alminium plate. As the result of that, we confirmed correspondence of analytical solution and with the result of simulation. The value of stress and strain of Steel was bigger than that of AlSi12.

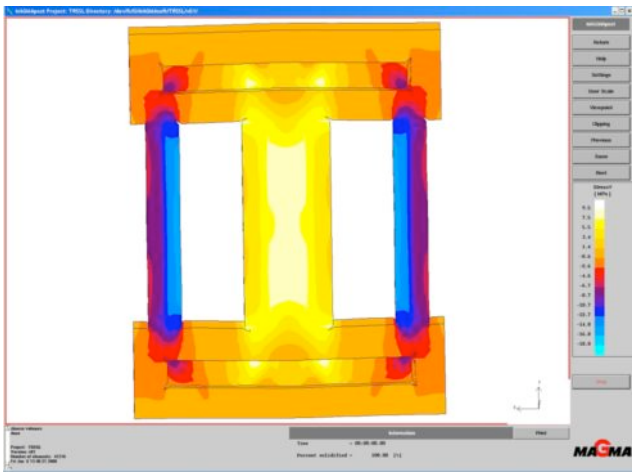




Transient and Residual Stress in stress Lattice

I analyzed the transient and residual stress in the situation that casting of a stress lattice is cooled down. The lattice has two different thickness bars. The lattice has possibility to suffer some crack because of different speed to be cool down. I discuss how two different lattices get cold and stress experienced at a point.

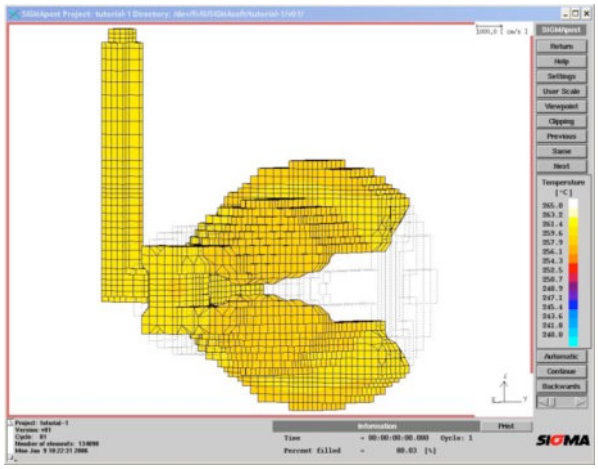


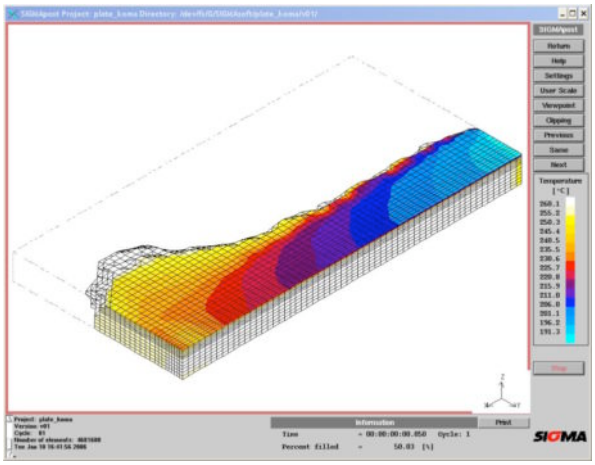


Numerical Modeling of injection Moulding of Plastic Parts

I ran the simulation of injection moulding for making plastic product and analyzed with SIGMA soft. I discuss about the filling pattern. The problem is weld line which melts plastic smashes. It is weak point, because weld line tend to suffer some cracks. So it is necessary to make weld as little as possible.

In this section, I also analyzed the cooling time, development of a frozen layer, thermal effect on the flow in to the mould and heat transport in the mould.



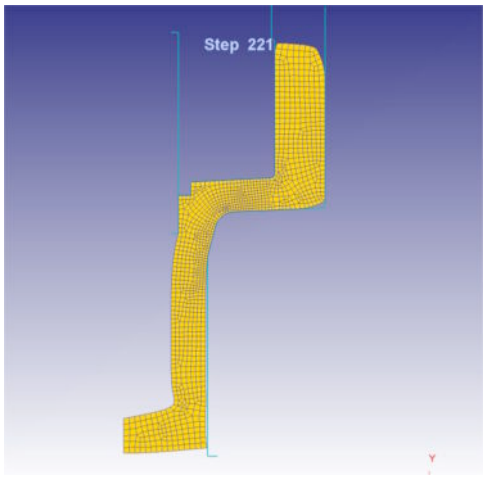


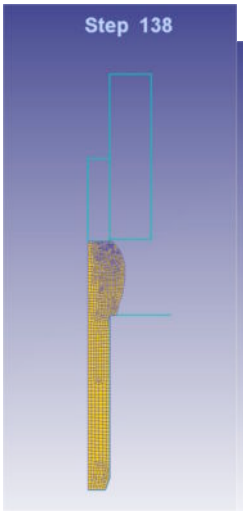
Simulation of Bulk metal Forming Processes

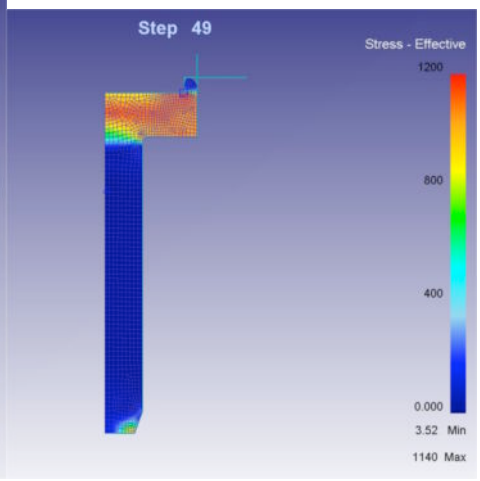
I studied Bulk metal forming with DEFORM. At first we made a steel component with several step of forging, and we simulate forging of a screw thorough the same way with DEFORM2D. As the result of simulation, Distribution of stress and load displacement curve when work piece punched

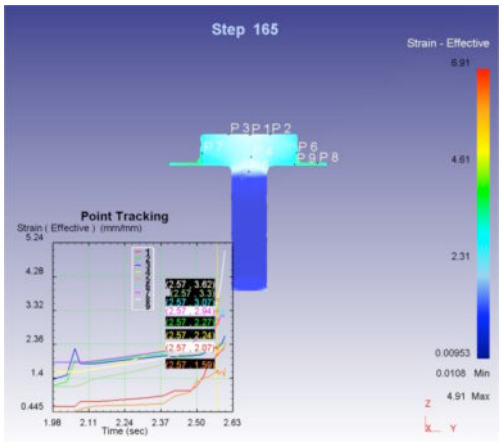
can be got, and we discussed it. When work piece punched to make screw, I have to put support parts not to occur buckling.

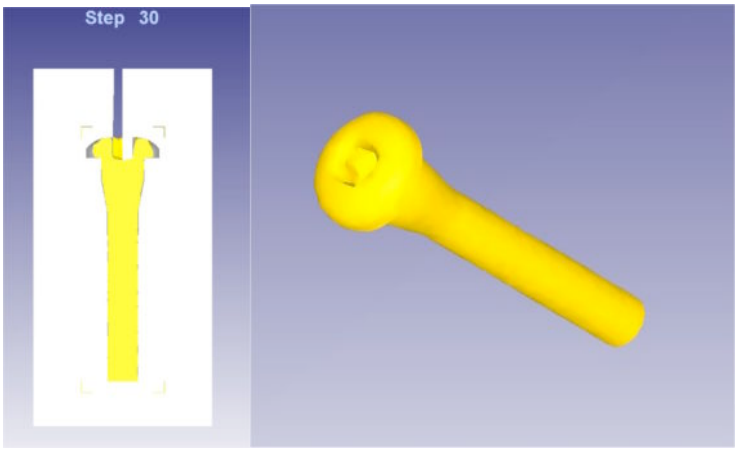
Next I used DEFORM3D to simulate forging of a three-dimensional screw. I drew top die in PRO-E and used it. I can know stress at a point where we decided. The part experience high stress is edge, and the part lower stress is center (especially top in center part).











Exchange Student Life

I have studied at Technical University of Berlin from September to December. Semester starts from middle of October. So there were not so many students in University on September. But teacher and researcher worked in theirs office, so I could start research. I mainly did research work. My research topic was Modeling and Optimization of Product Development Processes as I mentioned in section 4.1. I studied basic at first, because the topic was not my major in Japan. Once a week I had meeting with my supervisor. Since I did not speak English Fluently and know technical term, it was always difficult to explain what I did in English. I learned English about this field as well as my research topic through my research work at TUB.

I also attended a lecture from middle of October to December. The title is Systematic product development I. I thought the students are active than Japanese students in a class. In Japan student only listen to what teacher speak. But in Europe the teacher sometimes ask questions and students answer positively, and students ask some questions too. Another good thing is that the lecture had a group work. We discussed design of machine for removing land mines and presented it in the group work. We learned more deeply through the discussion.

I lived in dormitory in the University in Berlin. There were many students from foreign countries. Almost Students speaks English, but some students cannot. They can speak only German. So it was difficult to communicate with them. But in technical University everyone can speak English. When I went out (for example supermarket, restaurant, train station), some clerk did not Speak English, so I had problem about communication there too. At the other dormitory where DeMaMech students lived, everyone can speak English and they ware so friendly. So I sometime went to the dormitory, and had a dinner or party. When I talked with someone who speaks English, it was sometime difficult to tell what I think because of my poor English.

Anything at supermarket in Berlin is cheaper a little bit than Japan. I was surprised that there are many kinds of sausage, cheese and beer. Especially beer is much cheaper than Japanese one. In Berlin I wanted to eat Japanese hood. So I often cooked rice and something for dinner. I went to Menza which is cafeteria in the university for lunch. The hood at Menza is cheaper than Japanese cafeteria. We had lunch which costs about 2 Euro. But hood at restraint is more expensive than Japanese.

I moved to Denmark end of December, and I have studied at technical University of Denmark on January. I took an intensive course about metal casting, injection moulding, casting and bulk forming. In this lecture I mainly did exercise with simulation soft.

I lived in dormitory (Campus Village) in Denmark. There were students from various countries. I talked with them in a kitchen, and sometimes there was a party on a weekend. I talked with students who were from various countries. So I could know about not only Denmark but also their countries. I was always interested in what they explained about own country. I could know many cultural differences there.

In Denmark hood which is sold at supermarket is much expensive. I was surprised at price. And quality of Vegetables and fruits is not good. Some of them have already gone bad at supermarket.

I had good experience and learn a lot of things about not only Engineering but also culture

through my stay in two countries. I experienced many cultural differences. I had many troubles about communication and difference of culture. But the trouble made me grow up. I got various knowledge from various people who came from various countries.

4. Suggestions

We had to 2 countries in this project for 5 months, but I wanted to decide how many countries I went (one or two) by myself. I attend a lecture, but I could not get any credit at TUB, because I could not stay until end of semester. I got credit at DTU. I mainly did research work at TUB. So I have experience research work at TUB and taking a course at DTU. It was good for me. But at Delft they can get a credit there and also done research work, so I think it doesn't need that they changed university. If we are only a university for 5 months, we concentrate own research topics. On the other hand if we go to two universities, we can know cultural difference and have many experiences. But our research becomes shorter. If we can decide how many university we go by ourselves, I think that we can study better.

In the case of TUB, the semester begins middle of October. But I stayed there for 4 months from September. I could not get any credit because I could not stay there until end of semester. If we stayed whole Semester from October, we could take some course as well as doing research work.

6. Summary

I did research at TUB and took a course at DTU as I mentioned above. I studied Product development process at TUB and Metal casting at DTU. I could also learn technical term in English through research and lecture. In my exchange student life, everything I experience is new and surprising for me. It is interesting on one occasion but it is frustrating to me on another occasion. I met many people and communicate with them. My English skill is not good. I am always in trouble when I explain something in English. But we were willing to understand each other carefully. My English skill improved gradually. Everything I experience that is not only study but also life is meaningful so much for me and makes me grow.