

DeMaMech 2005 Report

Hareld van den Brink
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Delft

1. Personal Data

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2. Executive Summary

As an exchange student from Delft University of Technology to Osaka University, participating in the DeMaMech program, I stayed in Japan from February 16th to August 12th 2006. I worked at the laboratory of Prof. Eiji Arai, which is part of the section Advanced Manufacturing Systems of the Department of Materials and Manufacturing Science of the Graduate School of Engineering of Osaka University.

During my stay I performed a literature research on worker-oriented planning and scheduling in manufacturing. The worker-oriented approach to workforce planning and scheduling in manufacturing is focused toward the concerns and interests of the workers involved in manufacturing processes. This approach does not replace, but comprises the general applied feasibility and efficiency approach. The literature research focuses on various relevant aspects regarding workforce planning and scheduling, and gives an evaluation of several models for workforce planning and scheduling and applications of the worker-oriented approach from research and practice in manufacturing and other fields. It finally results in a qualitative overview of constraints recognized in models and applications which involve worker-oriented planning and scheduling. The literature research provided me insight in a huge and mainly open research area, and will form a good basis for future research on this topic, which I intent to perform. Additional to the research I visited seven Japanese manufacturing companies. During the company visits I participated in presentations and lectures, and did get to see part of their manufacturing process. My laboratory arranged the opportunity to interview representatives involved in planning and scheduling

activities from two of these companies. They also arranged a visit to the *CS21 Fujii+Kaihara* laboratory of Kobe University during which I interviewed Prof. Kaihara. The visits and especially the interviews were very interesting and rewarding.

Next to my research activities I did many other things. Japan in general and Osaka in specific have a lot to offer. I spent leisure sight seeing, attending festivals and cultural events, going to museums, restaurants, bars and clubs or just wandering around in Osaka and other cities; sometimes accompanied by laboratory members or friends, other times alone. This was all a lot of fun and often very interesting. It gave me a good impression of the Japanese people and their rich culture, and everyday life in Japan.

Overall, I can conclude that my exchange to Osaka University was very successful. I am thankful to DeMaMech for offering me this opportunity and I would certainly recommend others to take the opportunity if offered to them.

3. Travel Schedule

15Feb	departure	Amsterdam	11:55
15Feb	arrival	Helsinki	15:20
15Feb	departure	Helsinki	17:20
16Feb	arrival	Osaka	09:50
12Aug	departure	Osaka	11:00
12Aug	arrival	Helsinki	15:20
12Aug	departure	Helsinki	16:40
12Aug	arrival	Amsterdam	18:10

4. Research

During my exchange to the Arai laboratory of Osaka University I performed a literature research. In this literature research, I approached workforce planning and scheduling in manufacturing from a worker-oriented viewpoint. Workforce planning and scheduling is an aspect of operations planning and scheduling. It respectively involves the determination of the workforce required to perform a collection of tasks in the future, and the allocation and assignment of the workforce to these tasks. The general objective of workforce planning and scheduling is to generate feasible plans and schedules to meet demand in time in an efficient way, while dealing with all constraints involved. Decision support systems for workforce planning and scheduling initially fully focused at feasibility and efficiency, and ignored the input of workers and their condition and preferences. This did not result in the intended effect and it is therefore now accepted that removing the worker element is not appropriate.

Workers are essential elements for an effective planning and scheduling process. To understand their role in these processes, physical, cognitive, social, organizational, environmental and other relevant factors regarding workers should be extendedly accounted for in decision support systems for (workforce) planning and scheduling in manufacturing. Furthermore, maintaining and improving worker enthusiasm and acceptance will be crucial in fast changing manufacturing environments. Workers attitude to work changed. They are more demanding to employers. Development prospects and flexibility are often considered just as important as gaining financial benefit. Additionally workers increasingly divide their lives into discrete bits, for work, parenting, traveling and leisure. Enterprises that successfully improve the condition of workers, that try to involve their preferences and improve both their satisfaction and performance, will benefit more from their workers and will increase their loyalty to the enterprise. These enterprises will therefore have a competitive edge. Nonetheless, aspects involving worker satisfaction and performance are often not well integrated or not accounted for in decision support systems.

A worker-oriented approach to workforce planning and scheduling in manufacturing is proposed to solve this lack of attention. This approach is focused toward the concerns and interests of the workers involved in manufacturing processes. The approach does not replace, but comprises the general applied feasibility and efficiency approach.

The literature research gives a qualitative overview of constraints recognized in models and applications which involve worker-oriented planning and scheduling. Constraints can be seen as a basis of planning and scheduling problems, because these problems are often represented as constraint optimization problems, where the objective is to minimize the overall violation of constraints.

In determining the constraints which can be recognized, several questions arose. How to evaluate and model worker satisfaction and performance? Can the worker be an active autonomous decision making element? What is the influence of organizational and cultural aspects on worker behavior? What is actually known about worker behavior? Can the constraints be categorized? To form a basis for answers to these and many other questions, the possibility of a clear distinction between planning, scheduling, dispatching and operating is analyzed and described. Additionally the functions, tasks, behavior, relations and environment of workers are analyzed and described. To understand the need for and use of constraints, constraint optimization problems and simulation techniques are described shortly. Considering these analyses and descriptions, several applications and models for planning and scheduling from research and practice in manufacturing and other fields are evaluated. This finally resulted in an overview of constraints recognized in models and applications. Conclusively awkward findings are discussed and future directions for research are suggested.

Being back at Delft University of Technology I will finalize my literature research essay under close and direct supervision. As a follow up to the literature research, I intend to investigate the possibility to create a simulation tool which utilizes the worker-oriented approach described above. If presumed possible, the next step is to actually build a simulation tool which utilizes the worker-oriented approach.

In addition to the literature research, my laboratory arranged the opportunity to interview representatives involved in planning and scheduling activities from the two Japanese companies Daikin Industries and Fujitsu Ten. I sent in preparatory questions before my visit. During the interviews, in which Ass. Prof. Tsumaya performed as a translator, answers to these and other questions were discussed, leading to more questions and interesting discussions. I also saw part of their production processes. Both companies are described shortly below.

- Daikin Industries Ltd., Air Conditioning and Refrigerator Division, Shiga plant: Manufactures air conditioners, air cleaners and refrigerators
- Fujitsu Ten Ltd., Kobe plant: Manufactures navigation systems, audio systems, communication systems and several other electronic devices for cars and home use.

I also visited the CS21 Fujii+Kaihara laboratory of Kobe University and interviewed Prof. Kaihara. The studies his laboratory is engaged in are closely related to the research I performed. Topics most closely related are manufacturing scheduling, multi-agent scheduling, autonomous system management and multi-agent systems. He could answer more detailed and specialized questions and provided me with some good advises for improving my literature research and for further research. I hope Prof. Kaihara and his laboratory will continue to play a role in my research.

Additionally I visited five other companies. During the company visits I participated in presentations and lectures, and did get to see part of their manufacturing process. Each of the companies is shortly described below.

- Denso Corporation, Nishio plant: Manufactures air conditioners, radiators, fuel injection systems for diesel and electronic fuel injection components for automotive applications

- Denso Corporation, Takatana plant: Manufactures instrument clusters, displays, navigation systems and various sensors for automotive applications
- Mori Seiki Co. Ltd., Iga campus: Manufactures CNC lathes, Vertical Machining Centers and Horizontal Machining Centers
- Sumitomo Wiring Systems Ltd.: Manufactures wiring harnesses and electronic components, mainly for automotive applications
- Toyota Motor Corporation, Tsutsumi plant: Manufactures the Toyota car models Prius, Camry, Premio, Allion, Cadina, Wish and Scion tC

The company visits and interviews especially did give me an impression of how the worker-oriented approach is interpreted in Japan and to what level it is applied. It also gave me answers to some of the questions risen during the literature research. Furthermore, I gave me some insight in Japanese industry and cultural differences which can be distinguished between Japanese and Western companies.

Although it was very interesting for me, I would not suggest others to only perform a literature research when participating in the DeMaMech program. First Japanese universities are less familiar to literature studies. Second it is easy to make the topic of your research to big if a literature research is the only thing you are working on. This is what I did initially. I suppose combining a literature research with a small research project is better, because then you will not be just working on one topic and need more practical guidance. It will also give you more changes to interact with other students, because some laboratory members might have worked on the same research projects or you will be working on it together.

Overall, doing research on workforce planning and scheduling in Japan was very interesting and is a valuable experience for me personally and I expect it to proof valuable professionally. Japanese manufacturing systems and control are famous for their performance, and only therefore already it was interesting to do the research in Japan. The Arai laboratory did a lot of research in the field of planning and scheduling and is well known for it in Japan. I appreciate the support of my supervisors Prof. Arai and Ass. Prof. Tsumaya during my research and I hope they will continue to play a role in further research on this topic which I intend to perform.

5. Exchange Student Life

Exchange student life mainly consisted of time spent in the laboratory at the university and sleeping in the dormitory. There was much else to complement this though. Below I will shortly describe university and dormitory life and how I spent leisure.

As a fourth year bachelor or master student at Osaka University you work in a laboratory, which is managed by (and often named after) the professor of the section. The laboratories usually are an open space in which about ten to fifteen students work. This setting makes that there is a lot of interaction with other students. Working in this lively environment as an international student gives you good impression of how students in Japan are used to work and how student life is organized.

During my stay at the Arai laboratory, the number of students regularly working there was twelve. At the start of the new study year in April, the composition of the group changed. This was interesting to experience, not only for meeting new people, but also because the roles the students have in the laboratory changed. My contact with the students varied. Naturally, I had most contact with the students who also spent a lot of time in the laboratory. Some of the students were shy, some serious, some entertaining and others really eager to talk to me; not the least because they regarded speaking to me an opportunity for learning to speak better English. All of them were certainly friendly and very helpful, especially in cases when I needed information or help with the Japanese language.

Because the exchange is mainly focused on research, time to study Japanese is limited and mainly focused on speaking. The speaking level I reached was very basic and just enough to get by. I had to be creative

and patience to have interaction with Japanese people who did almost not speak English. And although reading about Japan helps, you still have to find out how to deal with cultural differences by doing. Both aspects were interesting and sometimes confusing and challenging, but never a problem.

Besides by the laboratory, as an international student, you are offered many opportunities to make your stay pleasant and interesting, by several private and university related organizations. They offer activities, ranging from language courses to company meetings for job hunting. Next to activities they provide information through their websites and mailing lists, and arrange discounts for sightseeing and cultural events.

My accommodation, which was conveniently arranged for me, was a dormitory for international students, located a few kilometers from the university campus. It was easy to commute from the dormitory to university and back by train or bike. My room in the dormitory was relatively large for Japanese standards, but very basic. Bathroom, toilets and kitchen had to be shared with the 12 people living on the same floor. Four coin operated showers, located on the ground floor, had to be shared with all 56 people living in the same wing of the building. All shared facilities were in poor condition and badly cleaned and maintained. Encounters with cock-roaches were a daily experience, also in my room.

As typical for many Japanese facilities, this dormitory did handle rules and practices which have to be followed by its inhabitants. Even when accounted for cultural differences, the necessity and usefulness of some of these rules were hard to understand for me. I will illustrate why with the closing times of the facilities as an example: I usually arrived at the dormitory just before midnight, because I used to go the gym at night, directly from university. After a day full of activities, it is understandable that one wants to relax and socialize for a while before going to sleep. Possibilities to do this in the dormitory were very limited though, because visitors and even other inhabitants were not allowed in my room, and the only places where you could be together with others, the recreation room and the study room, closed at 23 o'clock and midnight respectively. Socializing outdoors as an alternative was limited by a curfew; the dorm is closed from 1 to 6 o'clock. If you did go out, you had to be back well before the curfew to be able to take a shower before going to sleep, because also the shower room closed at 1 o'clock (if the door was not locked, then the cold water supply was cut). Doing laundry after I got back was not possible, because the laundry room closed at 22 o'clock. So, to do laundry I had to get up earlier and then wait for the washing machine to finish. The closing times really limited my comfort and especially my flexibility. Other rules and practices were limiting me less frequently and were easier to ignore, but nonetheless also limiting my flexibility and disturbing, because the necessity and usefulness of them was hard to see. Some of the inhabitants really had to pay attention to the rules, because breaking the rules would be mentioned to their supervisor of the university they attended. This could have far-reaching consequences for them – like being expelled from a scholarship – therefore they really started to show anxious behavior while in the dormitory; their home.

Although the dormitory is called international, almost all communication with and information provided by the management was in Japanese. Since my Japanese speaking ability is very limited, I often had to find someone to translate. Also many of the inhabitants did speak poor English. I therefore did not have much interaction with them. This made that I spent leisure mostly with other DeMaMech exchange students and English speaking international students participating in other programs.

Generally speaking, the dormitory in which I lived was a backlash. The conditions at this dormitory were worse than normal Japanese living standards. I assume this unnecessary. With the knowledge that there are much better, more pleasant and equally affordable places to stay for exchange students in Osaka, I would suggest to find better accommodation for the students who succeed me.

I did spend leisure by going to the gym three to four times a week, participating in language classes, exploring the city, doing some sight seeing in the weekends (and on the occasional weekday off), and going out with others to restaurants, bars and clubs.

The base for all this was Osaka, a modern and pleasant city. It has a nice atmosphere, good transportation, catering and entertainment facilities, it inhabits friendly and helpful people, and it organizes numerous

activities and festivals. Furthermore it is centrally located among the most important cultural sightseeing spots of Japan. I explored many parts of Osaka, went to different restaurants, bars, clubs and shopping malls, visited museums, parks, temples and its castle, and also took part in some of its festivals.

Outside Osaka I visited many interesting and beautiful places, most of the times for sight seeing, sometimes for company visits. I will mention a few of the places I visited. I went to Kyoto, Nara and Kobe - conveniently located an hour traveling from the dormitory – several times. I was lucky enough to see these places during spring, the blossom season in Japan. A highlight for blossom viewing was Yoshino. I went to Hiroshima - with its impressive history - and visited nearby Miyajima. Another highlight was my stay on the beautiful islands Honto and Zamami of Okinawa for a week with four other DeMaMech students. Here we experienced tropical Japan and its colorful underwater life. I went to the striking beautiful sights of Himeji and Nikko. I visited Japan's diverse mega city Tokyo. Finally, I want to mention that I climbed the volcano Mount Fuji, to experience the characteristic sunrise of Japan from the edge of its crater. This is just a selection of what I saw of Japan; there is still much to see for me. Japan is rich of cultural sights and beautiful nature. I am very happy that I could combine research with experiencing Japan's culture and sights.

6. Summary

Studying and living in Japan for six months has been a very interesting and pleasant experience, which I value personally and I expect to prove valuable professionally. Studying at a foreign university is an interesting experience in itself. Studying at a Japanese university is even more interesting, because language difficulties and cultural differences are common and sometimes hard to overcome.

I enjoyed the literature research I performed. It provided me insight in a huge and mainly open research area, and will form a good basis for future research on this topic, which I intend to perform. Doing this research in Japan and visiting Japanese manufacturing companies while doing it, made the experience complete. I hope the people involved in my research in Japan will continue to play a role in my further research.

Spending leisure in Japan was pleasant and a lot of fun and really added to experience of the exchange. Sight seeing, attending festivals and cultural events, going to restaurants, bars and clubs or just wandering around in the city gave me a very good impression of the Japanese people and their rich culture, and everyday life in Japan.

I would suggest two changes. First I would suggest students who succeed me not to go to Japan to do just a literature research. I expect doing a literature research in combination with a small practical research project to be more interactive, productive and rewarding. Second I would suggest the organizers of DeMaMech to find better accommodation for the students who succeed me. The dormitory in which I stayed is not a pleasant place to stay. There are much better, more pleasant and equally affordable places to stay for exchange students in Osaka.

Overall, I can conclude that my exchange to Osaka University was very successful. I am thankful to DeMaMech for offering me this opportunity and I would certainly recommend others to take the opportunity if offered to them. I would like to thank the organizers of DeMaMech, especially Prof. Tomiyama and Prof. Fujita. Special thanks go to my supervisors Prof. Eiji Arai, Ass. Prof. Akira Tsumaya and Dr. Hans P.M. Veeke. Also I would like to thank the members of the Arai laboratory, in special Jindo Masanori my tutor and Satoru Nakamura, with whom I had many nice discussions in English. Finally I would like to thank Andrej, Freerk, Maarten, Zen and Kayo and Yin in special for the time we spent together.