DeMaMech 05/06 Report

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2 Executive Summary

I was participating the DeMaMech program from TU-Berlin to Osaka University from September 2005 till June 2006. I studied 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 worked on a theoretical research about representation of designers' intention and design information occurring during the design process in machine readable language. I was lucky to have the ability to discuss and research this topic with such highly capable teachers as Prof. Eiji Arai and his assistants Prof. Akira Tsumaya from *Osaka University* and with Dr. Kazuhiro Takeuchi from *Fujitsu Info Software Technologies Ltd*. This gave me a big opportunity to understand design processes from theoretical and practical sides as well.

In addition, I had a great possibility to get to know Japan, its culture and habits, a bit of Japanese language and last but not least to meet a lot of new friends from all over the world.

I would strongly recommend this exchange program to every student thinking of studying abroad.

3 Travel Schedule

September 2005
Berlin – Frankfurt – Dubai - Osaka

June 2006
Osaka – Dubai – Frankfurt - Berlin

4 Research

4.1 BACKGROUND AND PURPOSE

As mentioned above, my research dealt with capturing and storing of relevant information generated within the design process for 3D-CAD tools. The object was not only to store the successful design information, but also to try to record design alternatives at important decision points. Which could be helpful for later design improvement, failure analysis or breakdown for similar design tasks.

The objective was to propose means to transmit accurately the design information and intention from the upstream design to the detailed design stage. For this purpose, the principal architecture by introducing an integrated model with geometrical and intentional information was proposed.

4.2 SUBSTANCE

3D-CAD systems deal primarily with geometric models. During the process of adding and changing the geometric models, the design information and intention have to be considered. It is important to assume each geometric object of the model as a particular object to add design information and intention.

Basic operations in the 3D CAD systems are shape addition/modification and dimension setting/changing. Making a bore hole or creating a shaft is an example. Therefore the CAD systems should accurately understand what changes were performed

There are two kinds of design information. One is attached to a single geometric element (such as radius or surface roughness) and the other describes the relation between two or more elements (parallelism or coaxiality for example). Both types of design information should be able to be treated by the CAD system.

The certain behavior according to the content of design information and intention should be able to be defined in the CAD system.

For instance the relation between two objects has been changed after some operations performed on the geometric model. The following reaction by the CAD system should be different depending on the design intention. In some cases the system should reject this kind of change operations in other cases execute the instruction and delete or overwrite the relation with a cautionary feedback.

Moreover, when the permissive range has been decided such as length or surface roughness, behavior should be different according to this value.

4.3 BASIC ARCHITECTURE OF SYSTEM BEHAVIOUR

To achieve the detailed and precise description of 3D-CAD objects the classification in 3 different levels was proposed.

- First order level is an assembly which is usually includes several parts. It can have all appropriate kinds of attributes, for instance dimensions, cost, robustness or noise.
- Second order level is a single part. It usually has a material or other properties like weight, specification, tooling costs etc.
- The last 3rd order level describes a single object of a part. It is usually represented by a geometric object like lines, areas or circles. These objects have two kinds of attributes. One is single design information, i.e. length, radius, surface roughness or coordinates. The other is relational design information; it includes such attributes as parallel/perpendicular, horizontal tangential, coaxial, symmetric or connected.

These and other attributes can be represented by the proposed Attribute Information Item (Fig. 4.1). It can store not only geometric or material properties but also designers' intentions and design information considered during design process.

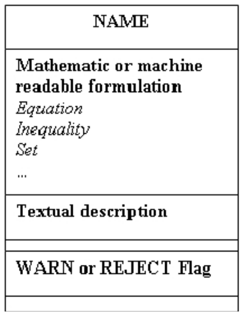

Fig. 4.1: Attribute's Information Item

The item has name, mathematic or other machine-readable formulation and textual description. The machine readable formulation is the most important part of designers' intention modelling using this kind of information item. The data stored in this part of the attribute has to be read easily by the behavior interpreter or transmitted to other analyzing systems (such as CAE or similar). Therefore we use equations, inequality, sets and other (mathematical) tools for this kind of description or assignments respectively. The textual description of an attribute contains a short statement which explains why the value of this attribute is chosen. This information item includes a kind of a flag, which can be set to deny any changing of this attribute or only to bring out a warning.

This Attribute's Information Item can be added to any design object represented by the CAD System. Designer chooses an important object and adds his intention or consideration as an attribute to it.

As described before design information can be attached to a single design element in case of single design information or to two or more elements in case of relational design information. The Attribute's Information Item allows considering these both types of the design information. Fig. 4.2 shows the Heat Expansion as an example of 2nd order level design information attached to the material attribute of the support. Radius is an example of the 3rd order design information attached to the radius of this CAD object. The relational design information 3rd order is represented by the Information Item *Fit* attached to the radii of the support and the shaft

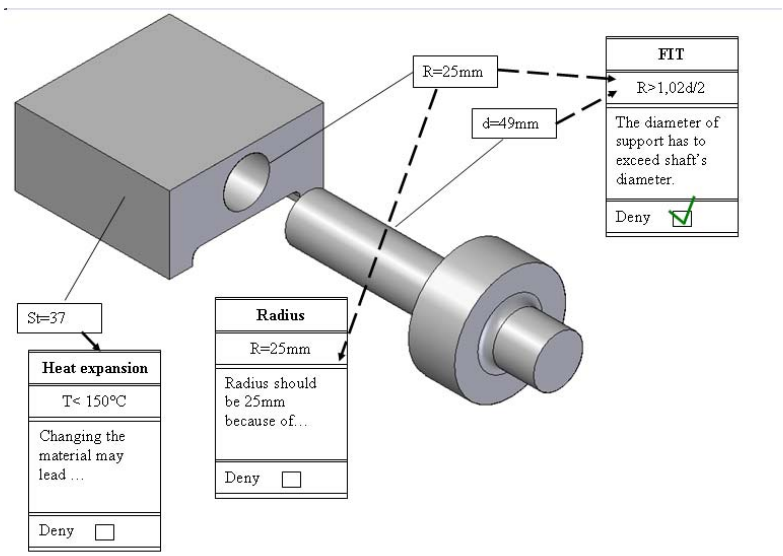

Fig. 4.2: Example of using Attribute's Information Items

After all important attributes have been set and other designer has tried to change the appropriate objects the behavior interpreter compares the new value of the attribute with the mathematical formulation. In the case the equation is still valid the system accepts the change. Otherwise system rejects (undo function) or warns about the change depending on the setting of the flag and brings out the textual description stored in the Attribute's Information Item

The introduced approach is also helpful for design change information. Typically, the designer must write the design change information for a report and as an amendment to the drafts. This can contain mistakes and be tedious and time-consuming procedure.

By treating the changes within the model as related to the certain objects of the model, these modifications are easily identified and documented.

Our architecture also includes some predefined routines for the treatment of prevalent routines. Thus it is easier and faster to create a new Information Item.

Foremost we offer a treatment of some geometric and material conditions. However, not only geometrical attributes and relations can be described in this way. The designer can add any other attributes to an object, such as electric resistance, transparency or allowed temperature range. After a new Information Item has been created, designer can decide to store this Item as a template for next sessions.

In some few cases, during the detailed or embodiment design designer realises the proposed condition from the conceptual design cannot be fulfilled. For example the radius of the borehole which was set to a certain value cannot be maintained for safety reasons. In these kinds of situations, designer should be able to ignore the rejection by the behaviour interpreter and continue with new values. However, after the information Item has been overridden, the designer has to create a new one with specific information explanation why the proposed condition could not be fulfilled.

4.4 SUMMARIES AND CONCLUSION

We proposed the architecture to achieve the transition of design information and intention from the conceptual design to the detailed design. The proposed architecture can transmit and handle various types of design information.

In the design process, it is very important to transmit design information during the whole process. The proposed architecture is an effective technique to support the design process with the designers' intention and design information.

5 Company Visits

In addition to my research my laboratory arranged the opportunity to visit several companies. I was able to visit *Fujitsu Info Software Technologies Ltd* in Shizuoka and have a discussion about the topic of my research with Dr.Takeuchi, who's department deals with CAD-Tools. I visited *Mazda Motor Corporation* in Hiroshima as well, where the company introduced their assembly line of the four-cylinder-engines. The last company visit was the *Denso Corporation* in Nagoya, where the companies assembly line for air conditioning systems was introduced.

6 Exchange Student Life

I was staying 10 month in Osaka. Thus I had the possibility not only to spend all this time on my research but also I put a lot of effort to get to know Japanese culture, friendly people and some of their sometimes curious habits, a bit of the difficult language, the adorably tasting food, beautiful landscapes and so on.

6.1 Accommodation

I was living in an international student house called "Senri International House". It was quite close to the campus (about 6 km) so you could get there by train and some short distance walking or bicycle. In my case one of my lab students (special thanks – Kazuya Inoue) offered me his scooter for free, so I could get to the lab in about 10 minutes without burning out myself by climbing the "1000 hills" (English for *Senri*) by bicycle. The gasoline cost are much cheaper than a train ticket – so my old white scooter was a object of "envy" of other exchange students. At the end it broke down though and I had to pay some perceptible disposal fee, but anyway it was a great fun and experience to ride a scooter on the "wrong" side of the road.

To live in that dormitory was an experience in itself. The stuff could speak no English at all and so it took a very long time to explain anything and as the case may be to get something explained. There was an 1 a.m. curfew which must not be broken, otherwise you get a very angry note in Japanese language in your mail box.

The building itself was very old and not good isolated. I was living there for all seasons and it was very difficult to hold on during the one of the coldest winters in Japan as well during the very hot and humid summer. You had to run air-conditioner all the time to achieve normal room temperature, which succeed some extremely high electricity bills by the end of the month.

Wintertime in the TV room

The shared kitchen and the sink area was very dirty and (especially in summer and autumn) full of cockroaches. This was the reason why neither me nor other European students ever used the kitchen. To take a shower you had to go 3 stories down and pay 50¥ for 7 minutes. There were 4 shower cubicles shared by about 60 student, so every morning it was a big challenge trying to pick not the dirtiest one.

There was a possibility to do laundry but only till 10 p.m. so as there was a common room with a TV and some newspapers which closed by 11 p.m. You were not allowed to have anyone in your room and if the common room was occupied by a reading or studying student there was no chance to spend any time by chatting with friends.

So I tried to spend as less time as possible in the dormitory. Usually after I woke up I went to my lab where I had some breakfast. For lunch and dinner usually I went with my lab members or other DeMaMech-Students to the canteen. After a long and exhausting studying day in the lab I tried to go to the gym where I could enjoy time unlimited showers, sauna and a hot bath.

6.2 Leisure Time

On weekends I tried to escape the daily routine and spend some time with my friends by going to clubs, karaoke, restaurants and sightseeing. But basically I tried to spend my spare time by travelling around the country. Several times I visited Kyoto, especially I was lucky to visit Kyoto one day while it was snowing. We visited silver and golden pavilion and went to a famous hot spring afterwards. At the night we had some different kinds of sake in a small sake-shop

Kingakuji in winter

I also visited a lot of Osaka surroundings like Nara, Kobe. I went to Himeji, Nikko, Koya-San, Hiroshima, Nagoya and a lot of others. For New Year's Eve, we went to Tokyo, were we had a kind DeMaMech-reunion.

Tokyo – New Year's Eve

In the beginning of summer with four DeMaMech Student we went to the beautiful islands of Okinawa for one week holiday. We visited Honto and Zamami where we experienced "a little different" Japan with colorful underwater life and very rainy season.

7 Summary

I stayed ten month in Osaka. Though at the end of my stay I was a bit homesick it was a great experience for me. I was able to research with a great team of students and professors and to learn to know Japan from the inside. All of this was a success during my stay and a profit for my future (career) life

This exchange has been a wonderful and unforgettable experience. I have learned a lot and I am grateful to everybody who made this possible. Especially Prof.Dr. Lucienne Blessing, Prof.Dr.Ing.Frank-Lothar Krause, Dr. Michael Schmidt Kretschmar, Prof.Dr.T.Tomiyama, Prof. Eiji Arai, Prof. Akira Tsumaya, Prof.Dr. Kikuo Fujita and the other founders of the DeMaMech exchange program, my Japanese lab friends in particular Kenichi Ninuma and Kazuya Inoue. Finally I would like to thank in particular Martin, Mikkel, Maartes L. Sem, Hareld, Freerk Maarten W., Zen and Momo for the wonderful time we spent in Japan together.