CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Going back to the general outline of this thesis let's review again the general objective of my work: *To research, to analyze and to improve the processes involved on the development and management of an internationally distributed project for product innovation.* In agreement with that and looking at the overall thesis the main goal was achieved at a hundred percent. I completed a deep research on the two roots of this thesis which are innovation and distributed work plus a research on many topics related to the core ones. Then I analyzed several trends and methods that are directly linked to this creative way of working as well as I analyzed (actually involved myself in) a particular case separating every minimal fact in an organized sequence in order to understand what happened with the processes involved and the work methodologies applied there. Finally, through all my work I made numerous recommendations to improve what has been done up to the present to get in the future better performance and the highest efficiency of the teams; those recommendations increase and make more sense in the last two chapters (four and five) on which, based on the compiled theorical information plus the case study, I strongly based my suggestions.

If the main objective of the thesis was completed at a hundred percent it is obvious that the specific goals were also fully achieved. I studied current processes of innovation and selected one as a basis for my methodology; I also studied into more detail what international distributed work is. I analyzed the problematic (or challenges) on those processes with an additional research on similar trends such as the ones presented in chapters 2.1.3, 2.2.2 and 2.2.3; and compiling the best of each research to

base the analysis of the dojyo case and to propose alternative improved methods. I put together most of the information to generate a plan, a general outline of a possible methodology of organization and work at distance when innovating products in an international cooperative environment which is shown in chapter four. I was involved in every activity of the dojyo project from its beginning to the present so I was able to observe, compile information and analyze the overall case. I was able to evaluate suggestions by us, the team members, into the pilot program of the dojyo. I present the implications that social, cultural, economic, technological and motivational factors had on the dojyo development. I suggested the use of specific communication tools applicable to projects like the dojyo. I completed my practical task as part of the flyguy's framework module by designing the body-support structure for the prototype. Finally, in the present chapter and also in appendix C one can find interesting ideas for improving in some way the mechanical engineering curricula currently offered by universities around the world. For example, transferring the Japanese model of super career paths to Mexico may be possible by adapting some of our current engineering education processes (e.g., by experiencing college engineering students with participation in international projects or by offering them courses related to the perspectives of being an international super-engineer. Thus Mexican graduates of engineering courses are able to participate in the super career path examinations and get a degree/qualification). A Mexican engineer can be also part of dojyos and of course receive distance education on global issues. Actually, in Mexico we are facing some problems that might be overcome by super career paths: a decrease of the number of design engineers (in Mexico most young engineers are focused to supervision and maintenance of already existing technologies

from other countries instead of own technology development); there is not much attention to the group work issue; there is too much creativity on many Mexican engineers but there is not to much innovative research due to lack of support from government (resources) for technology advancement and due to lack of interest of industry in sponsoring student projects or innovative projects; the industry-university connection in Mexico for doing jointly technology projects is poor not like the case of Germany where the work student-company is done almost always in parallel. Therefore qualified super-engineers will help to change and to improve those weaknesses in the present of engineering in Mexico.

Regarding specific objective seven and approach six (in the initial project document), with respect to my work there was a framework designed and built for the prototype of the sports-entertainment product selected by TANE; but this prototype was not the initially proposed ideal CSCS device containing all the specifications written in the first dojyo invitation. This new prototype was proposed under pressure time realizing that some changes to the initial proposal had to be made and was built with the purpose of experimenting some of the core functions initially established and reconsidering again and retaking the initial vision of the dojyo. In conclusion, it was developed to have a re-start on the team work and to re-organize the future work and on that way the prototype task was favorably.

Regarding the main objective of the dojyo I would say that the part where it states “the intercultural learning” was accomplished since through the different experiences in the dojyo either face-to-face or at distance, members shared their traditions and working style, learned new ones from the others and gained international experience. Members

also met the challenge of dealing with people from different countries and achieving a balance among their individual characteristics to work in a common path of knowledge and in a common task. The second part of the main objective says “the gain of experience in simultaneous group work” and if one just analyzes the results from the perspective of having a final marvelous product one would assume that this part was not accomplished. But if one looks at the overall process that during one year the whole team passed through, one realizes that the gain of experience does not come only from the positive results but also comes from the mistakes. In fact, in my opinion, the negative achievements are the ones richer in contents that help to learn and to improve future work. In the dojyo case, members tried empirically their best on working simultaneously and members learnt from the conflicts of disorganization at distance. That is why through this entire thesis I emphasized the importance of preparing people about the distributed work topic and I presented several methods and techniques to facilitate distance work in order to overcome the actual mistakes in next dojyo generations. Distributed work is complex but it is not that hard to accomplish whenever a good methodology or system is present through the entire duration of a project.

Finally, talking about the general product (CSCS) supposed to be developed in the dojyo I would say that the initial aim was not completed because there is currently the existence of a prototype consisting only in a framework plus some separate elements (computer, joystick, ventilator, and some sports equipment) whose objective changed from the complex initial one to the specific one of just testing the core functions as I mentioned in past paragraphs. The main reason that I attribute to the final result is the lack of coordination and work at distance by (overall) TANE members and the

incomplete development of the flyguy modules: mechatronics, visuals, network and game plan.

During the development of this thesis I respected the core structure and the work schedule established by myself never having remarkable delays or failures. The research plan proposed worked well in accomplishing my objectives and all the materials provided by my professors or by myself were of great help through my entire job. Finally, I applied all the proposed methods and techniques in the elaboration of this thesis. Now I would like to give conclusions and recommendations regarding the thesis topic itself.

In this thesis work I discussed the problem of managing a geographically distributed project for innovating products in the mechanical engineering field. Through all the systematic research for which I followed a deductive logic I found and presented every necessary topic for the correct understanding of the main one and studied the general terms of each area involved; then I took the particular points that specifically make up the core basement of this thesis and, without loosing also the inductive vision, I integrated those particularities into an approximately ordered arrangement which may be seen (not in a strictly manner) as a suggested methodology or a compilation of steps, factors and actions for improving the processes of innovating in a international distributed work environment. Following the deductive process again I went deep into an analysis of a particular case such as the dojyo project. Since I was actually part of it I could get the most of every experience during the complete project cycle and I was involved myself into the processes, work and results obtained by the team. Because of all the characteristics of this thesis it can be noticed how it covers entirely every part

commonly encountered in formal engineering research papers. I began with historical facts, then run into theoretical data, then synthesized the information, then generated methods, then applied all that knowledge into a real project and finally (and the most important aspect) I got and reported results either favorable or not but that are essential information to be consulted at any time, analyzed and improved with more innovative techniques that emerge in the future around distributed innovation.

My thesis is not a homogeneous set of topics that after mixing loose their own special features. Instead my work is formed by areas that complement each other and lead to determined applications and results. For that reason in this part which is the last I present conclusions and recommendations from the same perspective I worked through every chapter; that is differentiating the most important topics without loosing the focus on the general roots that compose this paper: innovation and distributed work, and without loosing the cluster of both and their importance.[2]

Innovation

Definitely innovation is part of today engineer's life and the success of a product in the market depends directly on its degree of innovativeness. That includes not only creativity on thinking but also creativity on the processes for generating solutions and creativity on the selection of the right people to achieve the best results, and creativity on organization.

In the present, innovation is not limited anymore by the boundaries of technical fields such as engineering; innovative work has now social, cultural, economical, ecological and global concerns. There is a reconsideration of the goals of traditional

[2] Conclusions are written in "normal" style and recommendations are written in **"bold"** style.

innovation and the innovations processes are being innovated theirselves converting the innovation task into a more flexible one.

Innovating in a distributed manner implies that innovation is being done cooperatively and multidisciplinary. Innovative products are not just technically oriented anymore but they are emotionally, physiologically, geographically and psychologically oriented too.

There are some aspects of innovation that shall be balanced: bridging always systematic and flexible innovation, creating and fulfilling needs through innovation, and mediating the idealizations with the reality.

Nowadays innovation is much more flexible respect to its realization processes and there are many approaches to realize an innovative product but I strongly recommend being conservative when selecting and applying methods of innovation; this is obvious since, despite of the flexibility allowed, a systematization is required almost every time so one does not loose the connection between every step in the innovation process.

Once an innovation process is selected, from the beginning to the end all the steps should be given the same weight, the same importance. As I remarked during the study of the dojyo case, everything was alright except that the end of the innovation process which is to select the solution was carried by the time pressure instead of by a formal procedure.

Before starting the innovation process and defining a product, team members must be aware of the work vision, work philosophy and the mechanical

engineering area they will be working on by participating in conferences, visits, activities, tests, workshops, etc.

Innovation is creativity, the act of creation is social rather than independent, and the innovation process needs the sharing of experiences. So innovation is actually a distributed process itself.

Distributed work

The management of cooperation at distance requires techniques, conventions, social norms, organizational structures, institutions support and people's culture of work. That is mainly what distributed work is about and it studies the way factors such as social relationships affect the strength of interactions between two people working for the same objective.

Coordination in teams is a wide bridge that links project tasks with achieving desired results. Coordination is so important in distributed teams that one should always look for the best programming mechanisms, the highest level of communication and the most practical team cognition mechanisms.

To build a virtual team is not an easy task. One must take into account the type of project, the product to be developed, the necessary skills, the degree of multidisciplinary work, the desired culture backgrounds, the geographic distance, the technology available and the personal aspects of each member.

There are some models of engineering work that encounter application or relation in the distributed work area and may be taken into account as tools. For example concurrent engineering coordination plans from some company might help students in distributed teams to figure out their own organizational style. One more example is the processes involved on global manufacturing such as international work, relationships, technology exchange and cultural adaptation; if one of them works well in an industrial

environment there are good chances that it works well (in a smaller scale) in engineering institutional projects too.

Distributed work is a good way to overcome the product localization challenges. Remember that localization is the process of adapting/orienting a product to a specific region. Logically, if a team is composed of people from several cultures it is easier to accomplish localization.

Communication is another essential aspect for distributed teams to be successful; one must try to achieve the best performance when exchanging information by making a good use of the latest technological tools. **For student level projects I suggested that the most useful communication tools are electronic data processing, electronic mail, electronic calendaring, computer conferencing, fax, imaging and telecommunication.**

Although distributed teams are formed by members from different disciplines and tasks are usually designated based on this criteria, the technology team concept (a team on which any participant is part of the product life cycle) should be taken into account. **In other words, the suggestion for members of a distributed team is that it is important to focus on their respective specific tasks but do not overcome the importance of being aware of the other's job and being aware of what is happening in the team.**

Distributed work does not mean separation, it means to work separately on a common task keeping in touch constantly, having frequent communication and meeting face-to-face any time it is necessary. **To ensure that a team truly share a common identity and bond a team leader can propose a code of conduct for example.**

The challenges of working on a distributed team include all the challenges of building a team that works at one location plus the added variables of distance, time and culture. **Please refer to the concepts of proximity and synchronicity defined on chapter three.**

Building an international team is not a simple task and there is no method for knowing if the group will work or not. However there are some procedures and models like the alignment model or the maturity model that help virtual teams to work effectively. In the case of dojyo it is clearly seen that the maturity of the team is relatively small (adhoc level) because we are pioneers on this type of projects and as I explained in chapter four, it takes much more time before a team can move on to the optimized level.

Distributed teams need to have an identity; it is important also to build relationships and trust among its members through aspects like fun, face-to-face meetings.

If it is to be called distributed team, the group should be conformed by more or less the same number of members from each location (e.g., five members from Australia, five from Taiwan and so on). When the circumstances do not allow this exact configuration leaders must make sure there are at least two members from the same location each.

More than the disciplinary factors, the cultural aspects of people have stronger influence in their behavior and performance on international projects. **That is why in previous chapters I emphasized some recommendations for leaders to deal with those challenges and to know the advantages of a cultural-focused management.**

Knowledge about innovation is ok, but knowledge about distributed work is necessary too. Both topics are equally important and decisive on the project realization and both should be presented from the very beginning of the project work cycle. **Team members need to be introduced into the distributed work field, providing them with basic theoretical information and basic training before they go home and nothing else can be done.** That is why the dojyo team had some problems working at distance since nobody was really introduced to the concepts of DW.

Organization, coordination, communication are very important for working at distance successfully and the best time to do so is during face-to-face meetings, not during the separation time. **Do not miss the chance of having the team seated around the same table to fix organizational structures, write down codes and norms, make written plans, establish time schedules, etc. That before departing home every member understand clearly what he or she has to do.**

Looking at the participant countries contributions to TANE's final product, the cultural influence was reflected in the following way: American Continent's way of thinking is "making life and things simpler" and that was reflected on the design of the first prototype which was easy to build, flexible to work with and adaptable for adding elements. Specifically talking about Mexican culture, our people are very creative and always look for simplifying work. The German innovating style was present in the flyguy too. Systematic approaches as so organized Germans are in their way of thinking-acting leaded TANE to a nice solution which was the flyguy. Japan's cultural contributions to the product were mainly the commitment and the respect to work and to present on time smart ideas mainly on the electronics area. The most remarkable part of the cultural influence in the dojyo was the flyguy concept itself which was chosen among members from different countries with different cultures and despite of that everyone converged in a solution that is globally accepted.

Finally, there is no defined methodology that solves all problems of working distributelly but an analysis of case studies like the dojyo together with a good theoretical research may help people, managers and teams to understand better the processes, to implement them on their own works and to get good results.