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COMPETENCES OF AN ENGINEER

AN IMPLEMENTATION IN IPD

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Abstract

It has become a topic at Dutch educational institutes to feel not only responsible for improvement of theoretical and practical skills, but also of 'competences' in a broader sense. The curriculum of the Electrical and Electronic (E&E) Department has been changed enormously in the past decade. Fewer lessons and many more projects were introduced. We have choosen to let the students work on competences especially in the projects they are in. With the introduction of competences and the aid of a student portfolio we have given the tools to the students to improve their competences in a broader way.

At the E &E department we introduced two different ways of working on competences. In the first years of their study students choose different roles in our projects every time. We have described all the roles and the related tasks for each specific role. While working on a role, the students indirectly work on different competences. This way of working inforces a broader educational level (a student shouldn't work on things he already knows or is able to handle) and the "hitch hiking" behaviour is banned out. Students now do take responsibility while contributing to the project teams. Inquiries amongst the students confirm these results.

The second way is working on the specific competences in their traineeship and thesis work in the last part of their study. This will be introduced in autumn 2004 in the E&E department.

In this paper we will show you how we are implementing the integration of competences, like the E&E department did, for IPD projects as well. This implementation is planned to start in autumn 2004.

1. Integrating competences in the curriculum

In the past, curricula were developed from a perspective of building up the knowledge, which the student would need in order to deliver outstanding work in his future profession. These items of knowledge are still relevant but they are not adequately 'translated' in order to fulfil specific engineering tasks. Knowledge only is not sufficient anymore. With competences someone can have more 'feeling' for the specific tasks that make an engineer competent in his profession. These competences are descriptions of proper behaviour in specific situations of an engineer, leading to a successful performing in one's job. Building a new curriculum based on competences will provide the possibility of creating a sort of education that is anticipating for a practical engineering attitude. Apart from that advantage, the student may work on specific competences in a field he wants to stand out. The quality of the competences that a student has obtained will be logged in a so-called portfolio. This portfolio is a report of one's

capabilities in the field of his future profession. It is very important that education will contribute to the realisation of the career-based expectations of the student. These career-based expectations will be crucial while advising the students' personal training plan (PTP), making the "route to travel" more adequate.

In the Netherlands all institutes are working on competence based learning. On national level the competences of an engineer are explored and named. They are divided in general competences (for all engineers necessary) and specific competences, which depend on the background of the study (as Mechanics, Information technology, Electrical Engineering, etc.)

First of all it has to be clear with what career expectations the student entered his or her studies. Often it is very difficult for the students to express these expectations. But anyhow, confronting the student with this question will make the student more aware of his or her implicit goals when selecting this type of education. In our system each student will have a mentor to help him with this task. The student will keep the same mentor for his or her total studies and so one of the tasks of the mentor is being his personal coach. During the first sessions they have together they formulate a way to explore the various fields of professional duty. As soon as the student has got an idea about his or her career it is possible to formulate a "dream profession" for the student. And to ensure he will be able to make this dream come true he will make a kind of plan of approach. So he writes a personal training plan (PTP) and a personal activity plan (PAP) for the period of his study.

But here is a problem: most of the Electrical & Electronical students don't like to work like this. They just want to work technical and don't like to formulate their learning goals, their PTPs, PAPs and prove their level of competence.

2. Implementation

So a difficult part in working with competences is how to give a suitable follow up to the plans that were made during the definition of the students "dream profession". We decided that the project team coach and the mentor do have an important role in this work. The mentor discusses and approves together with the student his or her personal trainee plan (PTP). This plan describes the learning route of the student throughout his or her studies. And here we came with the introduction of the team roles and tasks belonging to those roles. If one carries out a role, one also works on competences, implicitly! Choosing a role is equivalent to choosing certain competences. Working this way makes it all much more clear and acceptable for our students (and colleagues!).

We came to this idea by just looking at industry around us. We found out that most industry in our region is way out of production-oriented development: they mainly focus on flexibility and innovation (figure 1). The most common way to organize product development is working in (project-) teams with team members participating from different departments (flexible) or from different companies (innovative). Think e.g. of team members participating from the mechanical department, electrical, commercial, software, etc in the flexible development or specialised companies (back to the core business) for innovative product development. If such teams come together they discuss project planning and individual results from each member. These results are reached by that person or by a team of his department. Back at his own department the team member will discuss content, and planning of the

process with his chief of the department or his colleagues. These kinds of discussions don't take place in the project team meetings.

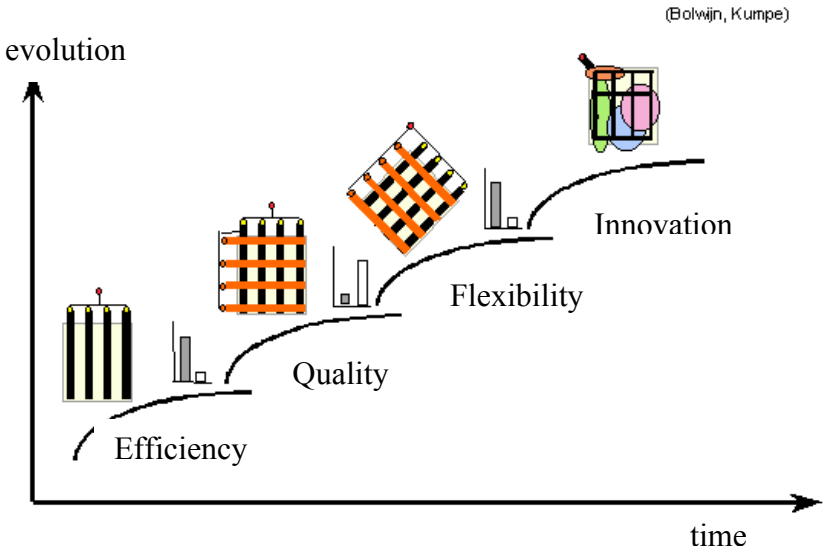

fig. 1, Organisation of companies

This way of working is also implemented in our project organization in our study. Reason was the reluctant attitude of our students to work with competences in the first years of their studies. Now we introduced roles for each project. These roles are known and used in the industry as well. Think on e.g.: software designer, hardware designer, mechanical designer, etc.

For each role one student takes the responsibility: he will report his findings to a specialist in that discipline. Furthermore he will organize his team to work with him on his assignment to get his job done. While working on a role he implicitly works on competences but in a way the students feels as 'natural'!

All roles are described in a clear and understandable way and also the tasks belonging to each role are defined. In this way the students are aware of the work of each different role to be done. That is necessary because we do want our students to choose roles for all projects at the end of the first year of study. We also want our students to fulfil all roles at least once during his study. In that way we are ensured that his basic study of the first two years is broad: he has encountered many different aspects of engineer's disciplines and of the general engineering competences. Within the projects each student chooses a process role (as project leader, communicator, administrator, report generator) and a project role as described before. By carrying out a specific role a number of times a student can work on a specific profile he has chosen. Think in this case e.g. of a digital designer who has done three digital designs in different projects. In fig.2 one can find the roles, our project set up, the deliverables and the location in time.

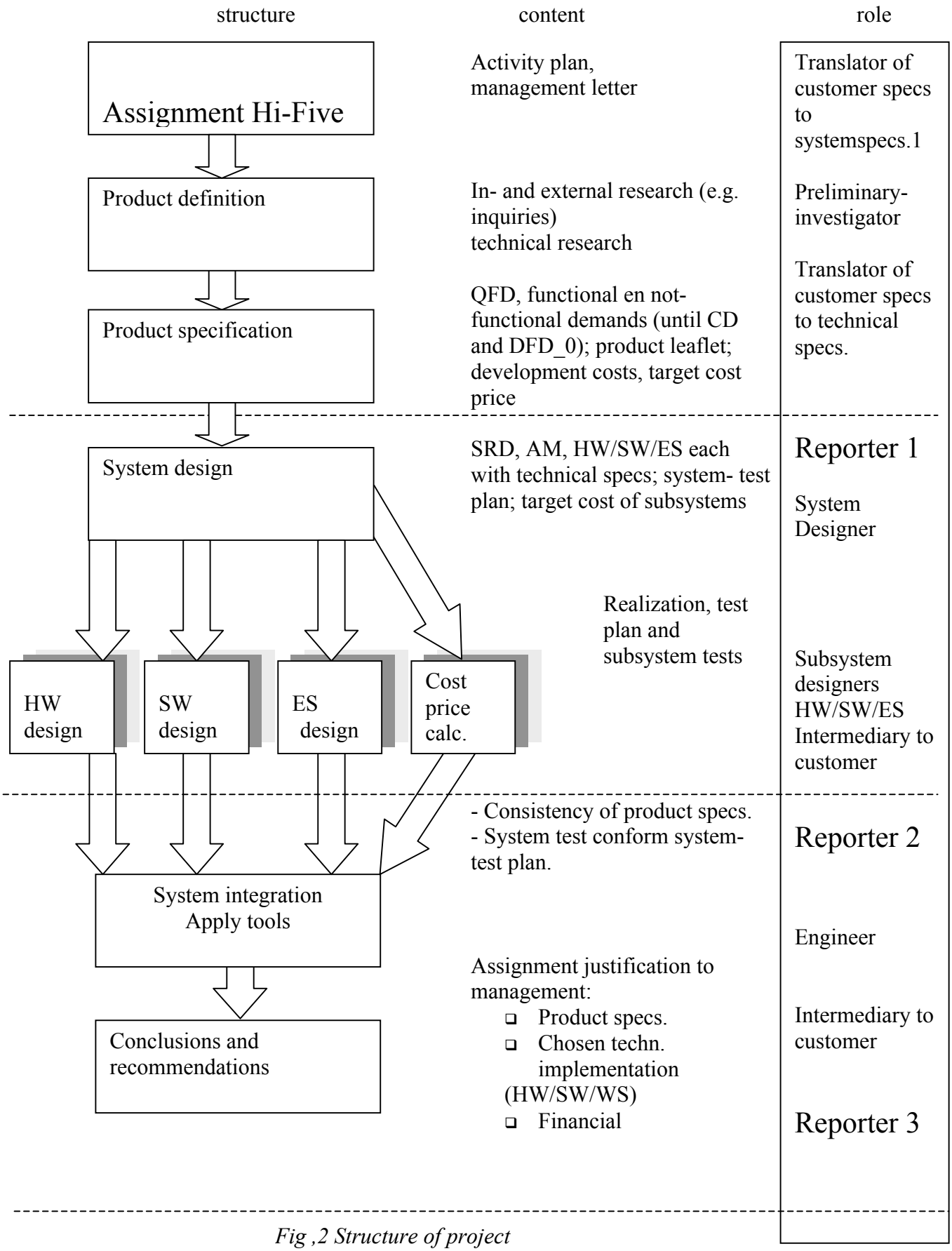

Fig ,2 Structure of project

This way of working needs an organisation to have all run smoothly. Therefore each student has his personal mentor to help him with his individual study route. Together with his personal mentor, the student writes his PTP (so called POP-1) for the first 2.5 years of study. Of course it is not possible to get this plan clear in one shot. So after every year mentor and student will come together and will discuss WHAT is achieved, and HOW. This discussion is based on the reports on the peer assessments that the student has got from his fellow group members. The coach of the group will also report his findings. All this information will be kept in the portfolio of the student.

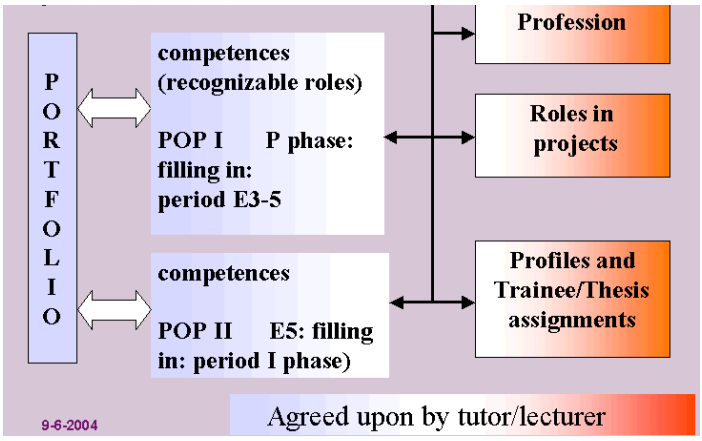

fig 2: organisation of process

The student writes a new personal activity plan (PAP) every half a year. The PAP is more a working document, and therefore updated more frequently. The PTP can be seen as the long-term strategy and so reviewed only once a year. In the PAP he will write down which roles he will focus on in the next half a year and on what specific individual goals he intends to give special attention. These individual learning goals are based on the PTP and given place in the projects by the coach and fellow students of the team.

Of course he will also write down HOW he intends to achieve his targets. This PAP is handed over to the coach and to the group members at the start of the project. So everybody knows about each other's current 'drives'. In evaluation sessions feedback will be given on these goals. In such a session students will write down positive remarks and improvement items.

One may understand that the PTP is a living document that may change once and a while. Once a year the mentor will discuss the progress and the objectives that were mentioned in the PAP with the student in relation to the PTP. The student's view can be changed by the experiences he had in that last year which has of course influence on his long term targets written down in the PTP. It will always be the student who is responsible he should come up with changes and proposals. The portfolio, PTP and PAP are means to guide a student towards the end of his or her studies and to a proper start of a job in the world of engineering.

In the last period (year and a half) of his studies the student encounters the real engineering world by visiting 'students doing their thesis work' in the companies, visiting alumni and visiting professionals in his "dream profession". In these visits he will try to find out which competences are driving forces for success in that environment. He will compare that to his own competences and from this comparisons onwards he will describe on which competences he wants to improve and how. He will select the company to fulfil his trainee ship, which modules and courses he wants to get education in and which profile he wants to specialise in. This all is written down in his PTP-2 (POP-2) and discussed with his career mentor.

3. Evaluation

Our students had many complaints when we started to integrate competences in their studies. It took them a lot of time to understand the meaning of it and a lot of time to get started. Many of our technical students thought that this shouldn't be part of their studies. "If we would have liked to do this job we would have choosen some other studies" they said in the beginning. So we figured out that we had to bring the copetences in the study in a more natural way. We found out that working in teams and projects with specified roles could be this natural way. Now students tell us that this way of working helps you a lot in thinking about one's future and especially the feedback on personal behaviour from team members and coach was said as extremely valuable.

But working in projects also improved substantially. "It's a clear system which makes all students responsible for parts of the project. So it is not one projectleader who is responsible but all members feel responsible and get more drive!" as stated by students.

In this way of working the "hitch hiking" behaviour is also banned out! "If you don't work with me, I won't cooperate in your tasks of your role." This is the way to persuade everybody to contribute. In figure 3 one can find the scores on several aspects of working in competences via roles (in the E&E department, POP-1).

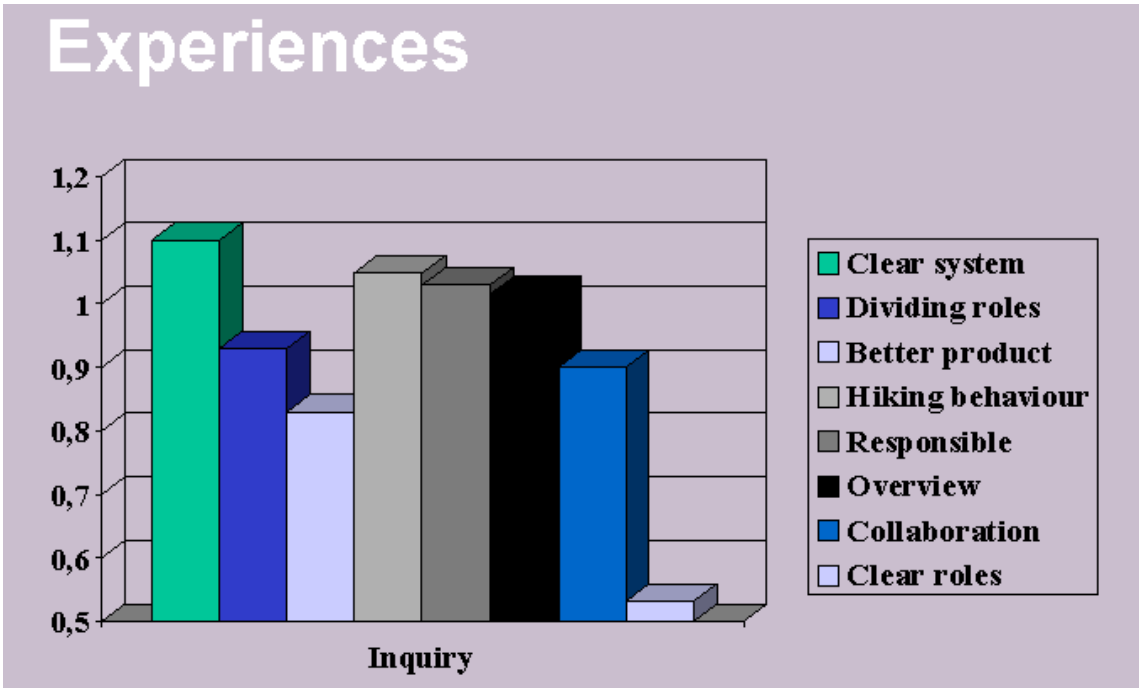

Fig 3: final results (E&E inquiry)

We also found some aspects to be improved as there are:

1. Make really clear what the roles and the tasks are belonging to that roles
2. Make sure that the group cohesion stays good and that students don't strive only for the best individual score
3. Make all information available to make it easy for the students to divide the available roles.

These findings made us decide to work in a simular way in our IPD projects. We are going to make this change because we found the same problems in our IPD projects as they found out at the E&E department: lack of responsibility, only a few hard working students, not clear what jobs had to be done, etc. Before we could start working in this way we have had to define all roles which the students had to play in our IPD-projects. Secondly we have to connect each role to a lecturer who would assess the role (and students) and we had to discuss the new task of the coach. In the end we think that this way of working will help to make the IPD projects even more succesfull!

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