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CAD TEAMS PERFORMANCE EMPOWEREMENT AND EVALUATION BY USING E-LEARNING TOOLS

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ABSTRACT
3D CAD systems are used in practical product design to realize simultaneous engineering and also to improve productivity. It is today acknowledged that CAD tools can highly increase design performances. Although 3D CAD is a widely used and highly effective tool in mechanical design, it also has its drawbacks: mastery of CAD skills is rather complex and time-consuming. In this article we primarily led an inventory of fixtures in CAD among several Engineering and Design Departments in order to see in which way CAD training can be made. We studied e-learning in an attempt to simplify the learning process and get performance evaluation in CAD. We depict a state of the art regarding e-learning in CAD research works and present commercial e-learning tools. We then compare four e-learning CAD experiments and strive to define the best learning and evaluation path for building a high-performance CAD training, allowing monitoring CAD users' competence.

Keywords: e-learning, CAD, competence evaluation, CATIA V5.

1 INTRODUCTION
In a more and more competitive context, cost and delay reductions as well as the global improvement of the performance of their activity are in the heart of the preoccupations of the industrial companies. Today, companies strive to get the "quintessence" of its employees to improve continuously their performance and reach the strategic objectives that they settled. This capital stock should thus be in the center of their problematic and organizational change actions requested to set up these performance improvements.
Training, management as well as company's know-how and knowledge are often considered as the traditional key component of a company. They therefore appear as priority action levers in order to tackle these global improvements. Focusing on the engineering and design department (EDD), in a context of knowledge economy, the ability to educate/train and apply methodologies and business rules as well as promoting knowledge management is a major asset for a design team.
Nevertheless, to set up these action levers is all the more heavy since it leads to a relatively important change process within the team, the department or the global enterprise. Specific tools and methodologies are therefore requested in order to reach these performance gains.
In this article, we are mainly focus on the case of the engineering and design department for mechanical product. The present works have been realized within the framework of the CODEKF project [1]. This project has been labeled by the French automobile competitiveness cluster "Vehicle of the future" in Alsace and Franche Comté areas in the east of France. This study is mainly focus on firms that are for the majority in the considered market area: rank 1, 2 or 3 subcontractors of the automotive industry.
We first of all depict an inventory of fixtures of the engineering and design departments of the companies, while precisely focusing on the way they use their CAD tools. We therefore analyze the particular case of e-learning research in design. We also draw up a landscape of the solutions existing in the CAD e-learning domain with the limits and lacks associated with these existing tools. We then compare and analyze the results of 4 experiments with e-learning CAD training allowing to monitor trainees' competence.

1.1 Research problematic

Our research problematic deals with the global improvement of performance in CAD. We are here particularly interested in the problem of training, giving methodologies and evaluation framework for CAD actors. The main scientific locks associated with this problematic can be found in the following questions:

- How to evaluate actors' knowledge, know how and competence?
- How to optimize CAD actors practices and gaining performance advantages?
- How to allow CAD actors competence monitoring?

1.2 Research methodology

We based or assumptions on industrial real cases studies, following the grounded theory methodology. We first of all lead an industrial survey among various companies working for the automotive industry in order to draw an inventory of fixtures in Engineering and Design Departments. We then focus on the training aspect, and specifically the e-learning training

2 INDUSTRIAL SURVEY: ENGINEERING AND DESIGN DEPARTMENT ORGANISATION AND CAD RESSOURCES MANAGEMENT

We lead an industrial survey in the field of competence of the "vehicle of the future" cluster area in order to have an inventory of fixtures of their habits in term of organization and CAD resources management. The Alsace and Franche Comté French areas gather some major actors of the French and European automotive industry: 87200 employees within 400 companies.

2.1 Field study framework and particularities

We selected a sample of 40 firms and lead mainly face-to-face interviews, as well as phone call and email interviews. Most of the time, answers come from the head of the EDD or project managers feedbacks. A specific characteristic of the automotive sector is the proportion of engineers (9%) regarding technicians (18%). This proportion of technicians is even higher in engineering and design department (EDD). This can be explained by the fact that, unlike the aerospace industry where designers have historically always been engineers, automotive design and engineering department are historically composed by draftmen with little or any engineering education [2]. Since the late-1980's, these draftmen has to shift to computer graphics and CAD Design.

Considering this fact we initiate our interviews following the three directions targeted previously as action levers:

- The management field;
- The Knowledge management and methodology management field;
- The training field.

2.2 Inventory of fixtures of the EDD regarding the management field

The notion of management gets in the EDD field in the operational direction only; the tactical and strategic levels being not, most of the time, within the competence field of the project manager or the person in charge of EDD. We wanted here to know the ways of functioning and the underlying organization for the considered EDD, by focusing on the aspects CAD use. The figure 1 reveals CAD solutions adopted by the sample group. The predominance of Autocad can be historically explained.

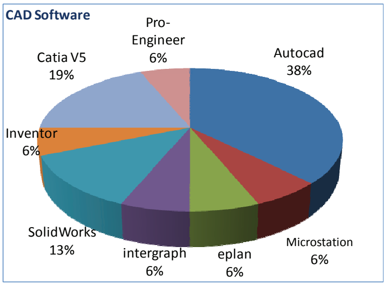

Figure 1: CAD software solutions

The fact that the EDD considered are small rank 2 or rank 3 subcontractors can also explain these choices, considering the financial investments in such a CAD system. CATIA V5 is also well represented because it is the standard of PSA Peugeot Citroën, the major principal in the area.

Most of the interviewed companies acknowledge leading some competence evaluation inquiry (70%). Concerning the EDD personnel, the evaluation is steered by the Human Resources Department (40%) or by the project manager (25%). We can notice that only 15% o the interviewed service use plycompetence matrix to evaluate and follow the competence of the EDD members.

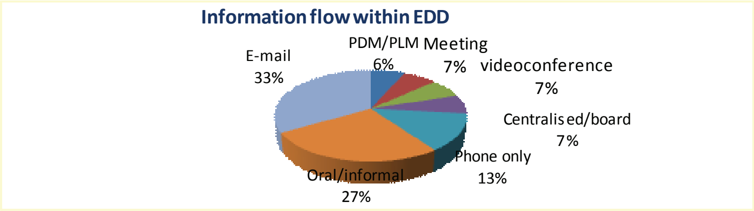

Figure 2: support of information flow within the EDD

Concerning the way the information flow inside projects is managed, the email is mainly use (figure 2). Informal talks are also usual. This relative non-managed information can be another time explained by the fact that the interviewed companies as well as their EDD were relatively small. Since the information flow is not really mastered, we will see in the next paragraph that the KM is also not really efficient.

2.3 Inventory of fixtures of the EDD regarding the KM field

We questioned the companies about their habits regarding Knowledge Management and CAD methodology used in their projects. 82% of the team leaders assumed using methodologies in CAD. When asking CAD users, only 51% acknowledged using them. 18% of CAD users know that a specific CAD methodology is existing for each CAD domain of expertise and only 12% assume having already capitalized their CAD knowledge. While investigating the way these methodologies have been set up, and where are they stored, a strange answer come from the fact that it was mainly informal or paper folder stored (figure 3). This means that they are must of the time not maintained.

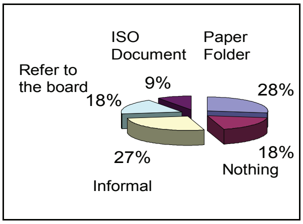

Figure 3: Ways of storing CAD methodologies

When dealing with the way the methodologies are acquired, for half of the companies using them, they used specific training. For the others, it is just informal explanations or technical notes.

2.4 Inventory of fixtures of the EDD regarding the training field

We wanted to dig a little more in the way the specific trainings are led in CAD. All of the interviewed persons assumed that, regarding the running developments in technologies, employees in the fields of engineering must frequently receive continuing education in order to remain competitive. For 70% it is outsourced by an Engineering Services Outsourcing (ESO) or consultancy firm. 15% use internal resources and only 5% use on-line or CD-Rom tutorials. Training duration is mainly higher than 5 days. When dealing with e-learning in CAD, only 20% of the interviewed have heard about this training solution.

While questioning about weighted priorities for CAD trainings, general improvements regarding the existing were mainly focus on user-friendliness and clarity of the courses. A special mention can be made to the fact that the cost is not a major problem (figure 4).

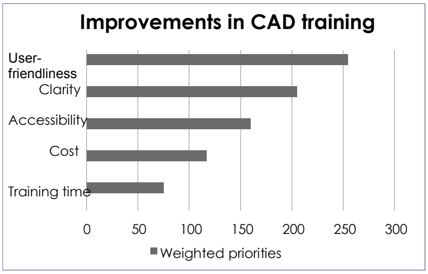

Figure 4: Improvements in CAD Training

This study gives us a real outline of the functioning of EDD working in the automotive industry domain in the east of France. We can globally summarize this study by noticing that certain needs exist within the framework of Knowledge Management, which is most of the time either non-existent or not structured; but also in the accompaniment in the development of new working methodologies via specific, structured and adapted training for the CAD users. In a framework of design performance improvement, e-learning thus appeared as a potentially interesting solution within the purpose of CAD training. Indeed, the computer support of CAD allows an easier use of the software tools with an already warned public concerning the use of IT tools. In the next section, we present the existing research works in the field of e-learning and specifically targeted towards CAD education.

3 E-LEARNING IN CAD

The e-learning market is rapidly growing. In the United States, the e-learning invaded the market of the education. In France, the e-learning was still shy a few years ago [3], but it is henceforth promised to a strong growth. The e-learning takes its development and knocks down the teachers educational habits. These ones become "knowledge integrator" via the new networks and have to manage new virtual communities of knowledge.

In our study, the e-learning seemed to touch only a small part of EDD. Only 20 % of them seemed to have knowledge about the potentialities of e-learning trainings in their activity domain.
If we refer to the data of the e-learning barometer 2008 [4]; this is completely correlated to figures found at a national level. Indeed, in the small structures (lower than 100 employees), whatever is the activity domain; the penetration rate of e-learning is lower than 10 %.

3.1 E-learning advantages

In a global way, the e-learning consists in using the resources of the computing and the Internet to acquire, remotely, knowledge. e-learning appeared as a revolutionary tool in the sense that the instructions which it offers on-line can be supplied whenever and wherever by a very vast range of solutions of electronic learning such as newsgroups, virtual "live" courses, video and audio, web chat, simulations…
The e-learning notion first appeared in 1993, due to the work of [5].
The general stakes in the e-learning are:

- Making more effective, more solid, more adapted the processes of learning and the access to the knowledge.
- To Benefit from advantages of the educational technologies (interactivity, simulation).
- To Benefit from advantages of the distance training (bigger autonomy, elimination of constraints) while eliminating the inconveniences of dehumanization.

Dealing with CAD, these stakes and advantages are mainly the same. The public concerned in our case (mainly computer-ready technicians) as well as the rapid advances in computer modeling, and the availability of many powerful graphics PCs and workstations, make 3-D modeling-based methods for personalized e-learning with CAD functionality feasible [6].

3.2 Literature review

A brief literature review about e-learning in the domain of design allows us to depict 5 center of interest for publications dealing with e-learning:

- Adoption,
- Efficiency / performance of the tool,
- Education Science (academic or enterprise experiments),
- IT/Software,
- Knowledge management and Ontology.

The publications concerned with the domain of Education Science are the most numerous (on-line courses deployment and academic experiments…).

As regards to the tool efficiency, the emphasis is systematically put on the adoption aspect and the organizational aspect for the creation and the follow-up of a community of learners [7], [8] [9]. A general synthesis from this literature allows us to claim that independently of the quality of the e-learning tool in itself, as well as of the educational contents quality or knowledge quantity capitalized in the contents, the success of the deployment of e-learning trainings depends on organizational aspects set up by the company or the concerned service.

3.2.1 e-learning and CAD contributions

According to [2], main streams for research in CAD; and especially for e-learning in CAD, have been initiated by engineering societies such as ASME [10]. We can also notice the growing number of scientific communications in the domain, within the field of the American Society for Engineering Education works [11]. Nevertheless, research works dealing with e-learning in CAD are still a few. We present here the main research outputs in the literature.

As in the general case of e-learning in design, the main part of contributions deals with Education Science. Culler et al. [12] state that data rich manufacturing environment provides an excellent educational platform for working in the emerging fields of E-Engineering and distance learning. In this field, [13] present a two-project sequence that provides students experience with several engineering tools and the feedback from this experiment. [14] analyze the effectiveness of a training program and e-Learning contents for 3D CAD that has been confirmed by cooperative activity between an enterprise and a school in mechanical design education. [15] presents a framework for an e-based mechanical engineering course learning. A case study and developed system implementation for CAD/CAM learning principals and integration are presented. In the same profile, [16] introduce the experimental setups for a case study of using SCORM based e-learning platform for the students taking a computer-aided drafting course in a High School from Taiwan.[17] present CubeExplorer, a hybrid 3D conceptual aid that complement conventional architectural space-training tools (such as physical materials and digital CAD programs).

Concerning the tool efficiency of e-learning for CAD purpose, the works led by Hamade [18], [19] deals with e-learning and CAD performance, but it is restricted to the point of view of:

- Speed of modelling
- Complexity of sketches
- Reduction of the number of "Features" for the creation of 3D models

The limits of these evaluation is that is does not take into account the environment of CAD tools and associated constraints in the company. They also do not integrate the ease of modification of the model to answer the design iterations. Their learning curves are therefore quite limited from an industrial point of view.

From a chronological point of view, the analysis of various publications on the subject shows that a change was operated since the beginning of 2000s [20].

The initial vision was made by considering the necessary competitive advantages of the e-learning:

- Distances abolition.
- Disappearance of the traditional “live” teacher.
- Flexibility of schedules and places.
- Pedagogy customization.
- Economy on the indirect budgets of training (movings…).

If some authors claim that traditional teaching doesn't always translate into learning, they have also experimented that a "full-virtual" e-learning course is also not so efficient.

3.2.2 New trends for e-learning in CAD

[21] assumes that CAD training is now mature, since CAD software have been around for more than 20 years. But it is the way the learning solutions are provided that has to be adapted.[22] states that the design field is currently preoccupied with the idiosyncrasies of e-learning, while it continues to grapple with ways of reducing design and development cycle time while maintaining quality standards.

Therefore, for CAD, as in every e-learning domain research, from a vision where the e-learning was considered as a substitute product in the traditional training, today we arrive at a situation where the e-learning is a support in the continuous learning. But it does not substitute itself to the traditional trainings.

This new way of perceiving learning is defined by several terms. Some authors call it "blended" learning [23],[24],[25], [26],[27], [28] . Some others prefer the term "hybrid" [21],[17].

Regarding CAD, a first study led by [29] examined a distance-based course using a high-end CAD package. This study found that it is possible to teach this type of course online and results showed that there were no significant differences between learning outcomes of students enrolled in the online version of the course versus students enrolled in the traditional version of the course. However, this investigation only provided quantitative results that lacked the ability to describe "how" or "why" different aspects of the course were or were not effective. Following Education Science research paradigms, [28] led a qualitative study in order to understand "how" and "why" these "blended" e-learning courses are the same or better than traditional teaching.

Concerning this new way of working in CAD training, most of authors are unanimous about its benefits, except [30] who still promote and argue for full on-line course.

Although e-learning and webcasts often can be the perfect replacements for traditional classroom trainings because they can be taken at user's desktops, must have many distractions within the office. The distractions prevent participants from being engaged and retaining the information in a synchronous e-learning event or Webcast. The most important factor is that individuals can choose which type of learning best suits their personal learning needs [21]. Following this way of thinking, [2] promotes that training should include exercises in modular design using CAD within a team environment. Training should also include a component on project management and on understanding important generic issues of CAD. Training should provide more than learning the 'picks and clicks' of specific software packages.

Emerging communities of e-learning CAD users are also the most common environment of informal learning. These internet-based e-communities are hosted on blogs, forums, chat rooms, message boards…[21]. Beginners can be here "mentored" by experts and CAD-superusers[2]. Even some software vendors such as Autodesk with the AUGI [31](Autodesk User Group International) offer dedicated websites and facilities to set up such communities and use it as a competitive advantages while promoting their product. We will see in the next sections that Engineering Services Outsourcing firms also use such an argument.

4 E-LEARNING TOOLS FOR CAD APPLICATIONS

As presented in the previous section, research works dealing with e-learning and CAD are quite a few. Most of the time they are led with self-developed or laboratory-prototyped software. [32] provide a framework allowing locating possibilities of e-learning tools regarding the level of guidance or the level of realism (figure 6).

They also present a state of art in the field of construction software instruction and training. They state that there are various approaches how to teach someone how to use a CAD/CAE application. They differentiate 3 steps in the e-learning software education:

- Awareness training (rather know that - How to use software, How to use software to solve particular problem),
- Full training (rather know how: Animation, Simulation, Testing).
- Performance support.

Unfortunately, they provide no tools' comparison in the field of mechanical design e-learning software. We also undertake a comparison of the existing commercial tools. We retained 2 categories:

companions and complete e-learning solutions provided by Engineering Services Outsourcing firms. We present our results in the next paragraphs.

4.1 Companion and Tutorial

User companions in CAD software as in any other software tool are on-line or off-line helps referenced by index or themes. They are supposed to give a hand when someone is using the software and want to use a specific function.
Tutorials provide guidance through example and exercises upon a defined module or several CAD modules. Audio or video contents can also be used to illustrate the purpose. Navigation within the help pages is possible via hyperlink.
As CAD software functions are not targeted to all users, CAD editors usually organize their tutorial in workshops depending of the skills to be acquired (for example Mechanical Design, Hybrid Design, Sheetmetal Design, Structural Analysis or Digital Mock-Up… for CATIA V5)
The limits of a companion or a tutorial are that they are just *showing* the process (cf figure 6). The "point and click" sequence actions are not embedded within a real context that can take into account the real needs of the CAD user. By the way, a tutorial must be run from the beginning to the end, wasting sometimes trainees time upon functionalities or modules that he will never use.
The main advantage is that they are most of time free and user-friendly use.

4.2 An online e-learning platform: I.Get.It

On-line e-learning platforms are most of time provided by CAD software vendor. We present here a multi-platform one: I.Get.It [33]. I.Get.it is an open web-based solution. It allows all companies to easily use and create its own trainings and assessments and define totally specific training paths in phase with its needs. Each training gives all the needed information, best-practices and tips found by experimented trainers. I.Get.It allows managing accurately the training and the growth of knowledge at the global company level, at the group of users level, at each individual user level thanks to a telemetry team module that monitor progress and edit reports. The e-learning process is carried through a 4 steps loop:
1-Skills gap analysis of the user or group of users (Use standard assessments or company customized ones).
2-Learning path (Create a training path based on the results of the analysis and use of customized trainings and company best practices) (as presented in figure 5).
3-Delivery the training with the adequate material (Use of the adequate type of training with immersive course or comprehensive course) in line with each user progression and capabilities.
4-Assessment: each training can be followed by an assessment giving the user the opportunity to assess his knowledge.
Two levels of customization are available: Customization of the existing courses, from the 20000 documents in the I.get.it library or creation of entirely new courses with an authoring tool by using company data (3D models, files, applications methodologies,..). Forums and community-building facilities are also provided.

Figure 5: I.Get.It learning path example with CATIA training

The best advantages of such a solution is that thanks to a personal login/password, the web access is available 24/24 and 7/7 (no need to be on the company network).

Specific trainings on company tools and rules allow having tailor-made sessions that are very effective in term of performance improvement.
The major disadvantage of such a solution is the costs that it implies: the license price is around 4000$/person for 5 years. Besides, it is a very good solution when trainees are beginners on the software but courses are very limited while targeting advanced functionalities.
Comparing with the companion or tutorial within Gajewski [32] framework (figure 6), it delivers more information that "point and click" tutorials (allowing to set up multiple paths learning courses) but do not allow full simulation possibilities since it is not embedded in the CAD software.
Except the case of refined tailor-made lectures, most of the existing course materials are not so efficient when training non-beginner CAD users because their purpose is too large and as in multiday traditional sessions, it take sometimes hours to take the new information needed instead of a few minutes if it has been accurately pin-pointed.

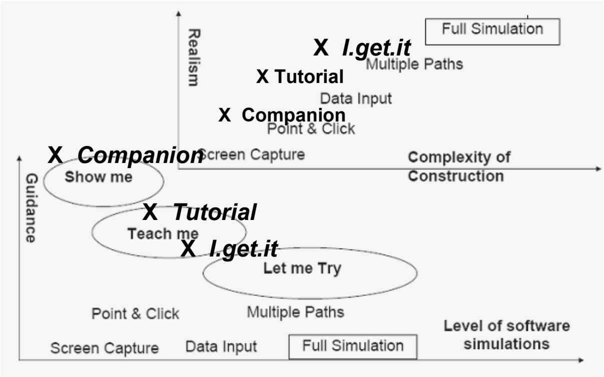

Figure 6: Locating e-learning commercial tools in Gajewski [32] framework

5 E-LEARNING EVALUATION FOR COMPETENCE ANALYSIS

In order to validate in which extent e-learning tools are able to effectively evaluate CAD users' competence, we analyzed 4 experiments run by INCAT [34] in the automotive industry field. INCAT, a Tata Technology company, is a global leader in Engineering Services Outsourcing (ESO) and Product Development IT services.

5.1 Experiments outlooks

We were project leaders for the two first and in charge of evaluation for the two last. The four concerned companies were Rank 1 automotive industry suppliers from the East of France. The experiment 4 concerned a major Rank 1 supplier with the aim of evaluating the use of firm's CAD standards worldwide. The other experiments were only local-targeted. For confidentiality reasons we were not allowed to quote companies names. The table 1 summarizes the experiments outlooks and results. The experiments were led during the first semester 2008 exclusively on CATIA V5 CAD support. Nevertheless, the software was only a training support and did not influence the results.

We mainly intervened at the end of the training schedule, during the evaluation phases. We present here experiments realized with hybrid or traditional learning methods. Nevertheless, all the evaluations where I.Get.It-based and realized through the e-learning evaluation platform. The evaluations are based on Multiple Choices Questions. An average of 5 answers is proposed. Only one out of the 5 proposal is the good one. Some weights have been instantiated regarding the importance or the requested expertise degree of the question.

Experience	1	2	3	4
CAD users in EDD	30	50	80	All CAD users worldwide (>500)
Traditional training	Yes ,1 year ago	Yes	Yes	Yes
I.Get.It e-learning training	No	Yes	Yes	No
Hybrid training	No	Yes	Yes	Yes (own e-learning course)
Tests type	85 MCQ (2/3 advanced CATIA functions, 1/3 customer own specifications (naming, standards…) + 90 min CATIA exercises : justify design choices (to evaluate behaviour + difficulties)	Preliminary audit on a sample to target evaluation needs. I.Get.It evaluation on 8 main tests (core of competence) + 4 complementary tests. 1H40 / user for the main test and 20 minutes for the complementary one. *Questions + collective correction*	I.Get.It evaluation	200 Multiple Choices Questions
Hybrid evaluation	Yes	No	No	No
Objectives	• To build project teams. • Define leaders and CAD users competence • Pinpoint methodological lacks and training needs	• Inventory of fixtures regarding methodological needs • Define personalized CATIA training needs.	• To assimilate methodologies and sign that they are understood	1_To define a CATIA training path regarding the trainee speciality (mechanical Designer, Kinematics…) 2_200 questions about firm standards to verify their application.
Results	+ inter-personal skills Best results because real competence profile	+ bring up to standard technically Allow to prepare tailor-made training paths. Global technical level optimization in CAD.	+ If good evaluation, that means that trainee follows methodologies. - Good results because only methodology oriented and no technical expertise feedback.	+ Corporate evaluation on corporate rules. - Only standard oriented: no expert competence evaluation.

Table: Experiments deployments and results

5.2 Results analysis

A first comment that is common to the experiment 2, 3 or 4 is that a good answer to a question does not mean that the targeted standard or CAD function is mastered by the trainee but only understood.
Experiment 4 occurred after a training period both led with traditional classroom teaching and own e-learning courses. The aim of the training was mainly firm's standards and methodology-mastering oriented. The underlying perspective was also to define training paths to re-train CAD users who did not achieve good results in their specialties. The test consisted in 200 MCQ I.Get.It-based questions. A main problem regarding the test outputs is that is did not take into account CAD user's technical expertise and could not lead to a real competence evaluation.
In another point of view, experiment 3 was based entirely on the I.Get.It platform and was only targeted towards methodology. Evaluation was based on I.Get.It standard questions about CAD methodology. Only a few questions were company's specific. As in experiment 4, the main problem with these training and final test was that they are just methodology-compliant. They did not deliver any information about the effective technical competence of the actor or any knowledge about CAD users' performance monitoring.
Experiment 2 has been run after a hybrid learning process occurred a few months ago over 50 CAD users from the EDD. The main goal was to draw an inventory of fixtures of the CAD users' abilities and pinpoint the learning paths to be setup in order to raise the competence of the weaker CAD users. A preliminary audit was led about the way users were working with CAD (modules used, standard, files sharing….). From these first results, a technical and methodological skills evaluation on specific domains was launched (8 different questionnaires depending the chosen specialty and 4 complementary questionnaires) over I.Get.It. The total test duration was about 2 hours. A collective correction was therefore done. Results from the test were translated:

- Globally (all departments results melting)
- By department
- By project

- By user.

Following the tests, a personal training path with modules and software functions to be rework has been setup for the weakest stakeholders. The advantage of such a test is that it allowed depicting a refined and personalised landscape of the training needs within the EDD. It also permitted to optimise the general level of knowledge and technical skills of the different stakeholder over CATIA (thanks to the collective correction of the I.Get.It questionnaires). I.Get.It tool here appeared as a good tool to evaluate knowledge and know-how (methodologies) of CAD users but was not sufficient to assume a complete competence evaluation since the general design context was not taken into account.

Experience 1 was led in an EDD of 30 users. The training occurred 1 year ago by traditional face-to-face teaching. Tailor-made e-learning solution was banned due to high cost of financial investments regarding the flow of people to be trained. The aim of the evaluation was as in the other experiments to pinpoint methodological lacks and training needs but has also a management point of view: to build project teams and to define team leaders and stakeholders competence. The test was based on 85 Multiple Choices Questions (2/3 about advanced CATIA functions, 1/3 about own firm specifications and company best practices (naming, standards, metodologies…) and 90 min CATIA exercises in which CAD users have to justify design choices. The first part of the test was run through I.Get.It. The second part of the evaluation was done in order to evaluate the difficulties they can overtake but also their behaviour regarding the way they are working. This second part marks were elaborated regarding the Predictive Index methodology[1].The evaluation criteria (the acquired level, the innate level, the quality of the work, the speed of execution, the work methodology, the learning capacity and respect of the rules) were gathered on a radar diagram giving the profile of each user and allowing monitoring performance while comparing with next/previous profile (figure 7).

In this way this experiment appears to us as the best one: it allowed defining CAD users skills in term of CATIA V5 design knowledge and methodology compliance. Beyond the technical knowledge and know-how, this evaluation has delivered a real competence monitoring, allowing defining actions to setup in order to improve actors' performance.

Comparing the results of these 4 experiments, the use of I.Get.It platform appeared as a very helpful tool while analysing CAD users' results. It is also very user-friendly when comparing and monitoring trainees' performance improvements. But it is lacking when evaluating knowledge-being and behaviour. In this way, it can not be used as a stand alone e-learning and evaluation solution and must be matched with other face-to-face tests in order to get efficient competence profile. In this way, it will be a very important asset for team project mangers or EDD managers while improving their teams' performance.

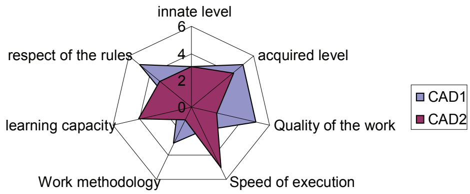

Figure 7: Experiment 1 CAD users profile

6. CONCLUSION

Cost and Delays reductions are now in the middle of the considerations of the companies. Multiple action levers allow these improvements thanks to new CAD software capacities. CAD software are always developing more and more functionalities and need more and more training in order to be efficiently used. But before CAD tools and functions are deployed, tools developed, it is necessary to train different users to take full advantage of the software application. A short inventory of fixtures allowed us to state that most of the EDD do not measure the performance gains that can be get in term of Knowledge Management and methodology compliance through effective CAD learning. We

[1] The Predictive Index was developed by Arnold S. Daniels in 1955 and since then has been continually tested to ensure its reliability as a predictor of workplace behaviour.

presented a state of the art of research works in the framework of e-learning for CAD and commercial e-learning solutions. We have then undertaken a 4 e-learning CAD experiment comparison. Experiment led through 4 companies from the automotive industry allowed us to state that the best way of evaluating CAD users' competence was a hybrid way, leaving place for behavioral profiling. E-learning platform therefore appears as a very useful tool to lead evaluation and collect results but is not sufficient for massive e-learning training and evaluation since the target of the proposed courses are too large. Future works in the domain can deal with the elaboration of an e-learning evaluation model specifically targeted to generative design and knowledgeware tools, since it is the concern of a lot of EDD.

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