INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15 – 18, 2005

Conflict management in engineering design: Industrial evidence from CO²Med software

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Abstract

In a context of increasingly demanding performances, different product design actors are invited to collaborate narrowly in order to conclude their project. These increasingly specific requirements in precise domains lead to a global increase of the actors' knowledge patrimony. The interaction of various types of knowledge during the collaboration phases highlighted the need for structuring this inheritance so as to be able to re-use it advisedly throughout the product life cycle, thus preventing possible conflicts. The multiplicity of expertises and viewpoints of the actors involved in the design project is an amplification factor of these conflicts. In this context, we propose a solution to manage and solve conflicts within design problems. Based on a framework for collaborative products design specifically dedicated to conflicts handling we propose a software infrastructure to allow the various conflict implied actors to structure their exchanges and to capitalize the evoked solutions with a reuse purpose in other projects: the ***CO²MED*** (***CO****llaborative* ***CO****nflict* ***M****anagement in* ***E****ngineering* ***D****esign*) application. We validate this one on an industrial case resulting from the design of a converter at Alstom Power Conversion Nancy.

Keywords: Engineering design, conflict management, industrial experiment.

1 Introduction

As complexity of engineering design processes continuously increases, they have to integrate a great number of expertises based on collaboration between the different actors involved. In such a context, project design management not only consists in allocating resources, but also in stimulating collaboration among the people involved in the project, in order to increase the performance of design teams.

In this paper we focus on collaboration between actors and particularly on knowledge which is exchanged during engineering design process. This knowledge has to be taking into account [1] in order to be reused in other similar design situations with the purpose of enhancing the global performance of the activity. Nevertheless, even if many many research works focused on development of strong collaborative tools, most of them do not satisfy the actual requirements for collaborating. As an example, we can quote the numerous works undertaken above CSCW application. As tackled by Klein et al. [2], workflow systems currently provide little support for adaptive processes. Most do not allow one to modify a process model once it has started executing.
Besides, most of CSCW tools focus on communication features (messaging) and coordination (approval forms, workflow tools, videoconference tools) but few of them are interested in collaboration among actors. Moreover, a gap between CSCW literature and software proposals and an integrated Product-Process-Organisation solution really exists. There are relatively few studies, however of the role of CSCW in Product Development and Design and

its effect on problem-solving activities [3]. A global repository for integrated product, process and organisation is therefore requested in order to specify some reliable and relevant software solutions for collaborative product design.

We directed our works on the case of the most forced collaboration form (corresponding to the case of prescribed and forced collaboration in Girard et al. [4]. We first go through the previous works led in the field and strive to highlight their lacks. We then propose a software solution for conflict handling in design set up on the basis of the analysis of these lacks. We based our proposal on the requirements for a conflict handling framework exposed in Rose et al. [5] to capitalize the exchanged knowledge and promote an infrastructure allowing these knowledge exchanges. We then propose a real case using of this software while analysing the various stages of a conflict resolution on a converter design and manufactured by Alstom Power Conversion.

2 Conflict handling in product design

2.1 The "Conflict" concept

Various definitions of the concept of conflict were proposed in the literature. However there is no general consensus around these definitions [6], [7], [8]. In a general way, "there is conflict when a decision cannot be taken by using the usual procedures", according to March and Simon definition, which remains simplest and most commonly allowed [9].

Conflicts management is a recurring activity in collaborative design. These conflicts, partly related on the complexity of the products and the multiplicity of the knowledge required figure out an average of 20 to 30% of the total duration of a project [10], [11]. In the same way, according to Schulz-Hardt et al. [12], the difficulties and ramparts to collaboration in the design activities can also come from the various conflicts appearing between the individuals during these activities.

However, conflict handling cannot be carried out by only one actor. It requires the mixing and the pooling of the various fields of expertises as well as collaborative knowledge [13] that is necessary to mutual comprehension, in order to define one or more acceptable solutions in response to a given conflict.

2.2 Previous work in the field

Matta and Cointe [14] proposed a model for the convergent design, in order to identify in which stages of the design the conflicts can appear and which type of method (prevention, argumentation or negotiation) can be requested to manage these conflicts. In parallel, Klein [10] proposed to extend and connect its taxonomy of conflicts with a taxonomy of conflicts resolution processes. These processes are subdivided in two classes, according to the fact that the conflict already took place or if it did not yet arrive. From a capitalization and re-use point of view, Klein proposes to deposit the various problems encountered in a design handbook. This handbook is a specialization of a meta-process of conflicts management, making it possible to specify which solutions were used, for which matter and at which time. This reference frame suggested and the tools for capitalization set up are unfortunately heavy and complicated to set up, and de not favour the direct access to this capitalised knowledge in case of urgency as it is often the case in conflicts management. An approach based on the use of Multi-Agents Systems to conclude a resolution is also recommended by Sigman and Liu [15] or Taratoukhine et al. [16]. Dieng et al. [17] propose the MULTIKAT tool in order to compare knowledge of several experts and offer strategies for conflict handling promoting the development of enterprise memories based on various strategies (on the greatest generalization, on the greatest specialization, on the greatest conceptualization, on a consensus). Golebiowska [18] proposes *Samovar* (System of analysis and modelling of the validations after conflicts at Renault), a tool and a method of knowledge capitalization in the specific domain of car manufacturing. This system relies on the elaboration and the exploitation of a project memory.

Most of these approaches are based on taxonomy of conflicts with whom taxonomy of solutions or methods for potential resolutions are correlated. However, excepting the reference frame suggested by Klein [10] on the basis of his previous work [19] defining the reference frame DCSS; none of these works show the existing bond between the process of collaborative design and the characteristic conflicts being able to appear in a recurring way to some of the stages of the process of resolution. This correlation would however be necessary with the aim of allowing an obvious and rapid comparison between situations for which the needs are similar to conditions previously met in a precise phase of the design process. In the same way, if the majority of these approaches have a method of resolution directed towards "Product" point of view (in recommending technical solutions), little consider "Process" or "Organisation" side of design conflicts. Moreover, the various taxonomies presented are all directed towards specific disciplines, but do not present extension or development possibilities in a given technical field. Lastly, if these works presents models implemented in prototype tools, their implementation remains quite confidential and requires a relatively huge software and/or hardware infrastructure, which does not facilitate their use and their proliferation in companies.

It results from this assessment that no answer seems to completely meet the needs relating to this activity whereas we targeted real need. From this point of view, we propose a system allowing management in collaboration of the conflicts of design. Referring to the propositions of Simone [20] concerning the organizational memory, we identified the following objectives for our repository for conflict management in a collaborative design repository:

- Adapt or innovate from the capitalized knowledge,
- Increase the collaboration,
- Manage the renewals of staff,
- Process the critical situations.

The following section presents a software solution able to answer these various needs in the case of conflicts management: the CO²MED software.

3 CO²MED: a solution to assist the conflict resolution process

Based on the model and the dynamic protocol established in [5], we propose a repository for the collaborative design of products (Figure 1) and we present here its implementation in the CO²MED (COllaborative COnflict Management in Engeneering) software.

3.1 Concepts of the proposed repository

Collaborative design process consists of several stages alternating between definitions of new solutions and adapting old solutions. Based on previous work in the conflict management field, we apply the cybernetic loop protocol on this situation. We can therefore highlight the

Observation phase of the conflict, a *Decision* stage about the solution to be adopted and *Information* to be brought to the involved actors (forwarding of the solution). In order to keep trace of the conflict resolution process (in terms of actions chaining and knowledge exchanged), we define an UML class diagram built around the class called “Collaboration Activity” (as a specialisation of an activity of the design process) to refer to the various resolution processes held to resolve different conflicts. Each “Collaboration Activity” is then composed of a set of “Iteration” classes. The “Collaboration Activity” class is instantiated to initialize the conflict resolution process. The “Iteration” class can handle several actions depending on the phase of the decision-process (arguing the actors’ choices, negotiating the proposed solutions, concluding the conflict…). The “Iteration” class was therefore specialized into three sub-classes in order to facilitate the capitalization of the conflict management process by keeping trace of the different intervention.

Creation of the collaboration activity: This part consists in giving a title to the new collaboration activity and in affiliating it to one of the elements of the ontology. This action is realized by the actor having discovered the conflict. The stake is here to affiliate the conflict with the component from the “Product” ontology on which the conflict appeared. A second referencing with an item of the “Conflict” ontology can be also realized to characterize in a more precise way the type of met conflict. In our case, the conflict concerned the sheet steel stator and we considered a conflict of resonance on the stator.

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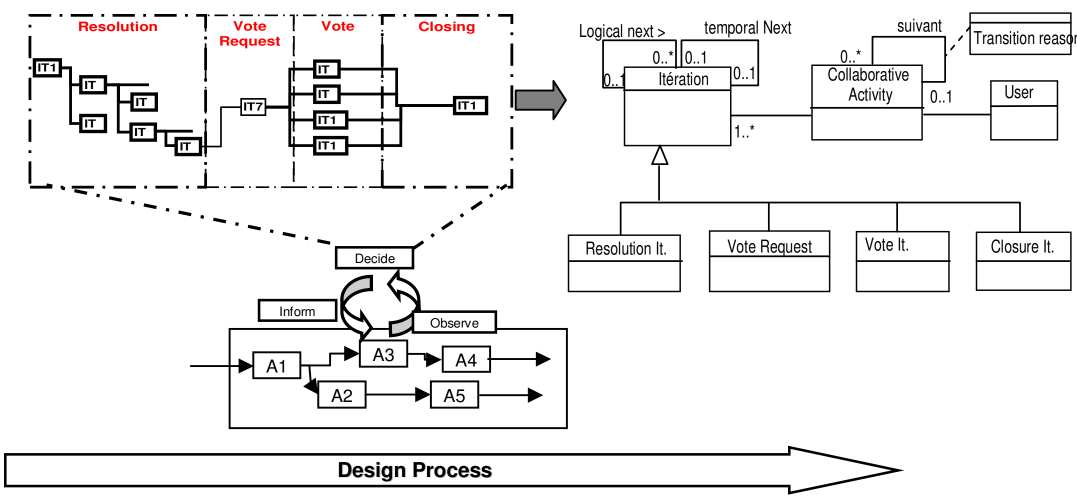

figure 1. Static and dynamic specifications of the proposed framework for conflict handling

Conflict initialization: Once the activity was created, it is necessary to initialize it by creating a first iteration in which the problem is explained. If information is missing, this will be asked by the concerned users in the following. In order to run this process, it is beforehand necessary to have chosen the actors to subscribe to the process of resolution of conflict, among those declared in the data base. The management and the subscribing of the best human resources by the project manager are essential in order to meet the milestones and the quality requirements for the product design. The software solution is supposed to help the project manager to lead this selection by providing some performance indicators. These performance indicators are risen from the past project observations of involved actors, regarding the type of collaborative work situation they are embedded in. Performance indicators are consequently supposed to precisely target the actors to register in the conflict list depending on their fields of competency, their workload, their creativity, their responsiveness…They also target their ability to criticize and/or to propose new solutions in a given domain or in a particular conflict case, regarding some specific keywords. This is realized via another page available via the menu.

Popularization and mediation of the conflict: Once the collaboration activity was initialized, the users previously selected can intervene by answering to the iterations already uttered via interactions formalized in explanations or justifications (Popularization of the conflict). During these exchanges, one of the users can take the initiative to create a new solution which can be discussed by the consortium (Mediation). Stakeholders strive to use popularization knowledge while running these phases of popularization/mediation, in order to be as understandable as possible to maintain a certain synergy within the established consortium. To help the actors in their interventions, the software is provided with an inference function allowing them to consult the various exchanges having taken place during the resolution of previous conflicts of the same type through the use of ontology. The provided arborescence permits to quickly target the structured solutions or arguments/explanations provided with the ad hoc knowledge previously used on a similar case (Figure 2).

Figure 2. CO²MED conflict resolution structure

Vote demand: A the end of a predefined duration Dj, in case of no convergence between the emitted solutions, a vote request message is sent to the various participants, meaning them the time which is granted to validate their choice from the proposed solutions.

Vote: Each subscribed actor must be identified to be able to vote and then chooses a solution among those previously uttered during the various previous iterations and valid his choice.When the actor sees that no solution is relevant, he can decide not to vote.The vote must answer to constraints regarding participation, vote and a specific timeframe [21].

Closing iteration is instantiated further to a friendly consensus obtained by explicit support of all the actors to a given solution before the deadline of the popularization / mediation phase; further to a consensus stemming from various iterations of vote emitted by each subscriber, or in case of vote process failure, by the project manager. The knowledge capitalised in this iteration permits to the project manager to capitalise this experiment and the stakeholders to reuse it in a future similar project. At this moment, since he will have optimise the contents of the design frame and the team composition by considering capitalised information about actors, he will be able to propose a design environment more efficient.

3.2 Technological choices for implementation

We implement the proposed specifications jointly with our industrial partner Alstom Power Conversion in a software solution in order to experiment it in a real industrial case. In order to answer to the constraints of distributed design and to insure flexibility within the use of the software, we chose a web solution to implement the repository previously presented. It is therefore developed in PHP language, run on MySql databases and is powered by an Apache Web Server. The ontologies are set up in PROTÉGÉ-2000 Software and are exported in an XML format in order to be rebuilt in an XML tree in the software.

3.3 Functionalities implemented in the software

The functional requirements of our software application were mainly described by the protocol of use as well as the UML class diagram of the collaborative framework previously proposed. This led us to propose:

- A secured and personalized access (users management module),
- A functionality of structured communication (via the explanation, justification and solutions fields) in order to be able to exchange various knowledge,
- A functionality of management of the activities of collaboration and iterations,
- A vote system,
- A system of storage for the iterations emitted,
- A performance indicators system dedicated to the human resources management and statistics.
- An integration of ontologies of conflicts as levers to index the various handled conflicts,
- An inference system, proposing solutions from the database of previous evoked solutions.

4 Application to an industrial case: contribution to the conflicts management in design of power converters at Alstom Power facilities in Nancy

4.1 Company outlook

ALSTOM Power conversion Nancy conceives and produced electric converters and auxiliary power units in the range of middle and high power (from 100kW to 30 000kW). The factory has a production capacity of 1100 engines/year and must provide approximately 2000 pilot studies in order to answer to the requests of estimate emanating from customers coming from various industrial sectors. The factor of series concerning the design and the production of the converters at Nancy facilities is approximately 1,8. However, the design activity can be characterised as routine design within the Engineering and Design department, regarding the fact that the main part of the orders consist in the customisation of models and solutions already carried out in the past. The work is therefore based on indexed solutions in the standard ranges of product. On the other hand, approximately ten orders/year represents completely innovating requests, requiring a strong collaboration between the R & D department and the Engineering and Design department.

4.2 Industrial bolt: how to index then to capitalise the conflicts?

Before capitalising the identified conflicts, it is necessary to be able to index them, in order to create a base of shared reflections and harmonising mutual comprehensions of the problem to be handled. To reach this degree of harmonization requires mastering the different meanings of the information exchanged between the various implied fields [22].

Ontologies can answer this problem. Indeed, ontologies provide a certain structure for the development of knowledge bases as well as a basis to generate sights on the knowledge bases [23]. They are thus defined to be able to meet an aim, expressing a point of view shared by a community. Their organisation in information batches, corresponding to a specific objective describes in a hierarchical structure of concepts and definitions [24], makes it possible to have a direct access to the profile or the required characteristic. In our case, ontology can thus be used as a reference when exchanging within the group formed to solve the conflicts observed. It is used in order to define and index the various conflicts, to compare them to the others and to restrict possible misinterpretations of the terms.

Within the framework of the study undertaken with our industrial partner, the only existing base of information regarding conflicts in the company was the consultation of the Quality Defaults Reports (QDR). Indeed, these reports are used as official media of communication within the company in order to index the various conflicts which have occurred from the beginning of the product lifecycle (development and design, manufacturing, tests, customer delivery and running period of guaranty). These reports are materialised within the company in paper version, distributed in various services and are centralised on a server and consultable by all the actors of the company.

4.3 Ontologies development

Our field of focus was located on the management of conflicts occurring or attributed to the Engineering and Design department. Following the consultation of the folder gathering the QDR of the past two years (approximately 3000 reports), we selected various points of view in order to ordinate these ontologies. To take into account these various points of view is necessary acknowledging that each actor of the company is supposed to be able to start a collaboration following the discovery of a conflict. These points of view were directed towards:

- The product, representing the nomenclature of the product,
- The product lifecycle, in order to index the conflicts according to their chronological appearance during the product life. We particularly focused on the conflicts occurring during the phase of engineering (calculations, geometry.),
- The organisation, presenting the conflicts on proposals according to a managerial point of view, with some distance compared to the technical elements handled (conflicts of comprehension, acceptability or communication).

“Product” ontology is in fact the nomenclature of a product. This point of view allow a person who perfectly masteries the product to be able to attribute the conflict to a particular part and to make a research to the various problems precisely related to this type part. We stopped at two levels of decomposition following the analysis of the different QDR selected.

Ontology “lifecycle” described, in the first stage of its typology, the various operations undergone on the product during its lifecycle. The interest of our work being restricted to the product design, we concentrated our actions on the “Study” stage of this lifecycle. We thus wanted to specify which are the conflicts met during the process at the study and development stage of the product. This was realised in pinpointing and referencing the various actions regarding a hierarchical basis according to the level of granularity of these actions. While

going down in the various levels from the tree structure, we also wanted to specify the conflicts having taken place on the elements or the elements at the source of these problems.
Ontology “Organisation” is, following the example of the “lifecycle” ontology, ontology of a general nature and represents the point of view of the organisation on the project. Realised on the basis of typology suggested by [14], it allows targeting the problems of comprehension, acceptability or communication inside the project, between the various actors and exchanged documents.
This ontology is interesting because it presents a point of view directed much more towards management than the two previous ones can be. These previous ontologies remain much more much more technical and dedicated to application. This last ontology is more targeted towards the index of conflicts of form than of the basic problems of these “procedural” conflicts.

5 Conflict management scenario with CO²MED: the 934 ARZ case

5.1 Study context

The conflict studied with the assistance of the software CO²MED related to the development of a carcass for an asynchronous power converter.
This high performances machine was different from the usual machines regarding the exceptional dimensions: the 2m section of the carcass was unconventional. The majority of calculations were carried out on the basis of a case previously carried out with a large carcass, starting from the plans and documents capitalised in the PDM tool. However, in this previous case, the bearings were not constrained. On the opposite, in the ongoing project, those must be fixed on the carcass. The total weight of the stator was of 17000kg. The bearings supporting of the ball bearings weight approximately 500kg each, and must ensure the guidance in rotation of the stator in the carcass.

This carcass presented a certain number of problems at during the test stage, following the manufacturing process. The converter failed during the test phase consisting in exciting the most important axial resonance mode of the converter. This experiment was handled in a range of speed from 0 to 3 times the defined nominal speed of this converter. For safety reasons, the power converter should not enter in resonance on a range of use including this range of rotation frequencies.

In order to precisely analyse the physical phenomena occurring on this converter as well as the solutions to be implemented in order to solve this conflict; a certain number of investigations and additional calculations were carried out on this carcass.
A 3D model was thus implemented in the ANSYS software by simplifying the geometry. In order to run the calculations resulting from a model fitting the reality, the total assembly volume was preserved but the density of the used elements was adjusted in order to obtain the right total weight of the machine. A 3D finite elements meshing of the machine was then carried out in order to carry out a modal analysis of the resonance of this machine (**Erreur ! Source du renvoi introuvable.**3).

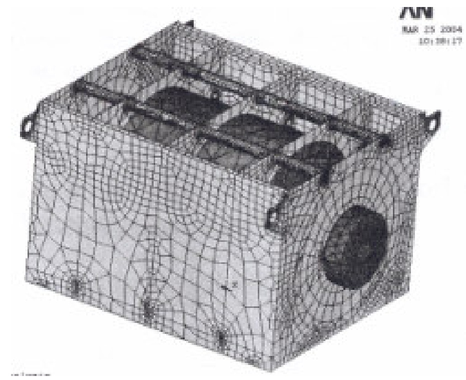

Figure 3. 3D meshing of the carcass with ANSYS

The next section presents the solving process followed, orchestrated by the use of CO²MED[1].

5.2 Initialisation

Declaration of the collaboration activity

Following the discovery of the conflict by the technician in charge of the tests within the manufacturing plant, information was immediately propagated to the person in charge of the project within the **Engineering and Design department**. This one started a collaboration activity in CO²MED. The technical cause of the conflict as well as the element in default being clearly pinpointed, he registered this conflict as being a problem of design related to the geometry of the element in question, and more precisely a problem of vibrations in the "Lifecycle" ontology. Concerning the choice in the "Product" ontology, the carcass was directly selected to reference this conflict.

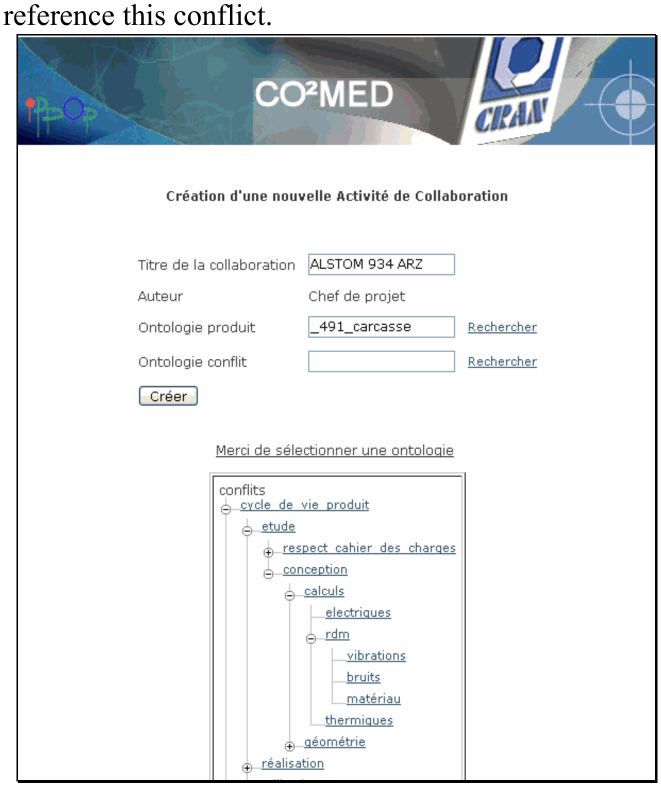

Figure 4. Conflict initialization via ontology items.

[1] For reasons of confidentiality, the data deferred here are it only as example and were modified compared to reality.

The project leader then initialises the project while targeting the characteristics of the conflict from the tree structure of the ontologies (**Erreur ! Source du renvoi introuvable.**4) and by keyboarding in a textbox the explanation related to this conflict, regarding the data available.

Actors Recruitment

The project on which the conflict occurred was relatively large and ordered by a important customer. A certain number of managers were subscribed to the collaborative task created with the aim of controlling the conflict resolution from a managerial and tactical point of view (with respect to the allowance of human and temporal resources in particular). These various stakeholders are indexed in **Erreur ! Source du renvoi introuvable.**. The selection of the "technical" actors was carried out regarding the experiment of each and the participation in the design of the machine. This was realised thanks to the consultation of the performance indicators stored in the database.

Table 1. Stakeholders taking part into the conflict resolution process of the ARZ 934 case.

Service Engineering and Design department: • 1 project leader **(responsible for the collaboration activity)**: *supervision and technical coordination of the team, contact with the customer.* • 1 expert in mechanical calculations: *Meshing in finite elements, calculation of the resonance modes.* • 1 designer: *mechanical dimensioning according to the obstruction specified by the customer, calculation of the constraints and efforts mechanics via a meshing in finite elements*. • 1 department manager: *in charge of the allowance of the resources to conclude the design.* • 1 person responsible for the Quality for the Engineering and Design department.
Manufacturing department: • 1 technician: responsible for the tests of the machine on the test bed.
Quality department: • 1 engineer in charge of the machine conformity.

5.3 Negotiation of the conflict via the resolution phases

According to the Engineering and Design department Quality manager, the conflict deals with a vibration problem, and he justifies his proposal by arguing that these abnormal vibrations are certainly due to the use of a non-standard element.

Some iterations are then created by the department manager and the project leader. They precise new details on the nature of the problem and the first elements to use to solve the problem. In fact, it is due to a part that is misused with this type of non-standard element. The department manager argues that the study for assembly and dimensioning of the advocated bearing results from calculations of cases previously carried out. The project leader corroborates this assertion (Figure 5). The engineer from the Quality department then asks for complementary tests. Once carried out, the results are compared and correlated with an analysis of the deformations in finite element of the vibration of the bearing in opposition of phase, according to a horizontal or vertical direction.

In a second time, whereas all the actors agreed and checked that the conflict causes were well identified, the designer proposes a first solution concerning the modifications to be made on the product: flasks stiffness modification by addition of horizontal and vertical stiffeners.

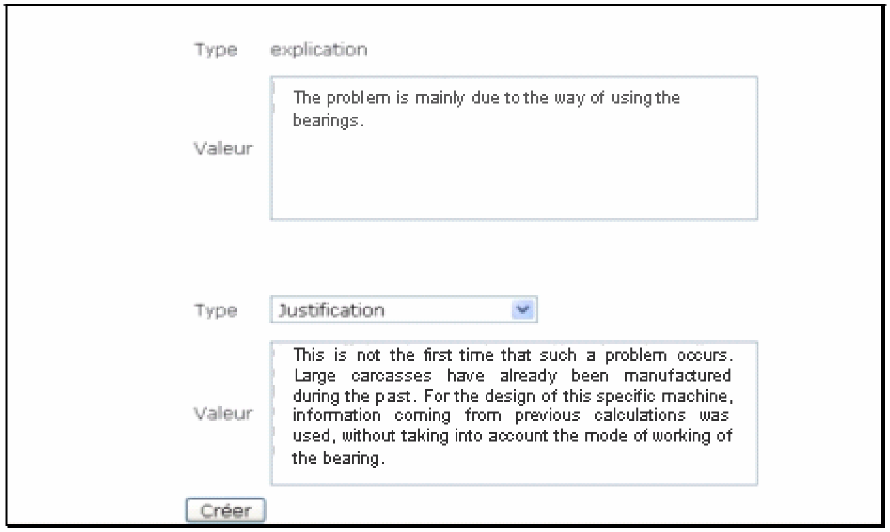

Figure 5. The project leader justifies the troubles

A new calculation campaign is then carried out by the actors from the Engineering and Design department in order to determine the own natural resonance frequency of the assembly. The calculated modifications are then directly implemented on the machine at the manufacturing floor.

New tests are carried out. Those however appear unfruitful. The project leader intervene while to expose new elements explaining the reasons for the failure of this solution.

5.4 Design contribution while continuing the conflict resolution

In a third stage of this conflict resolution, a second solution is proposed by the expert in mechanical calculations, going further on the modifications to be implemented on the structure. Following a dynamic calculation of the balancing of the assembly, he proposes to affix two diametrically opposite mass in order to reach this equilibrium. A new calculation campaign is then launched with the aim of determining the precise angular position as well as the weight of the mass to be added.

Following the consultation of the previous conflicts referred in the CO²MED database (via the ontology), the project leader recommends to apply a method for calculation previously used on a case of a converter fitted with different characteristics (dimensions much smaller) but reporting comparable vibratory phenomena during the test phase.

The recommended methodology allowed determining the values of the masses to be positioned and their angular positions.

Regarding the tests perpetrated after its implementation on the machine, this solution proved to be effective

The machine was therefore acceptable from a contractual point of view. However, the customer refused. He mentioned that the problem can possibly appear under different running conditions than the ones experimented on Alstom tests platform. Considering the fact that the problem was resolved but no perennial corrective action or solution have been proposed, the project leader and the top managers decided to go further with this conflict .

5.5 New knowledge generation via use of CO²MED

Following a new study campaign much more important (150h of calculations leading to a correction of the model finite elements of the assembly), a reliable and much more precise model was elaborated while following this methodology:

- Model loading,
- Resolution,
- Model adaptation / measurements,
- Modification of the model parameters,
- Model reloading ,
- Resolution,
- Loop until obtaining a usable model and satisfactory predictive results.

After the consultation of various vibratory conflicts indexed and capitalised in CO²MED, it was possible to propose a certain number of modifications following the combination of the solutions previously used. The modifications to be carried out proposed by the expert in mechanical calculations dealt with the increase of thickness on the flasks (the carcass being machined, only the flasks could be improved) as well as additional elements in order to increase the rigidity (1). The negotiation milestone being reached, a vote request was sent to the subscribed actors. The re-use of knowledge and experiments previously capitalised thus allowed creating a synergy of knowledge creation via the combination of the last experiments.

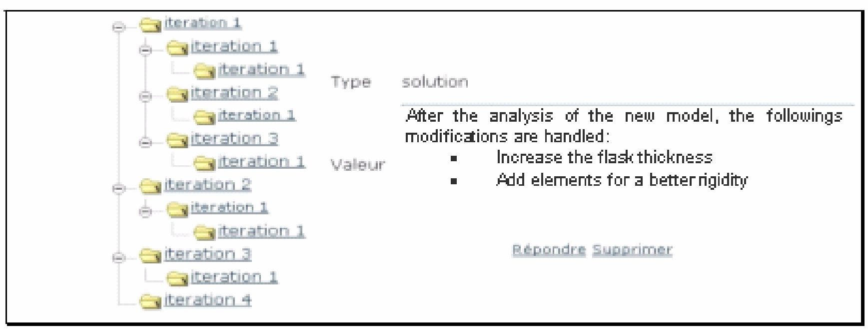

Figure 1. Proposal of a reliable and perennial solution

5.6 Vote and capitalization of the solution

The last corrective solution being most reliable from a modelling point of view (while improving the initial performances of the machine); it was unanimously selected by all the subscribed actors and was capitalised as being the standard solution with this kind of conflict.

Once modifications recommended in this solution taken into account on the converter always stationed on the site of production, a series of tests allowed validating this solution. The machine was then delivered to the customer who accepted it.

The project leader then closes the process of management of conflict and the various subscribed actors are thus informed of this decision. The various explanations, justifications and solutions concerning this conflict can nevertheless be re-used via the consultation of ontologies in other declared collaboration activities.

5.7 Contributions of the software for the company

This real life experiment demonstrates the advantage of such a software tool in order to help the designers in their daily work. It allows answering to their preoccupation of reactivity, of knowledge exchanges and capitalization during the confrontation of the various points of view exposed during conflict resolution. The “collective memory” infrastructure thus suggested leaves at the disposal of the stakeholders a panel of documented choices on the previous adopted solutions as well as those which were abandoned. It also meets the need for collaboration to solve these conflict situations and then help for the global performance improvement for the design activity in the company. This experiment thus demonstrates the interest to initiate a real knowledge capitalization policy within the company, and the influence that this one can have on the design organisation. Following the objective of enhancing the ergonomics and consequently a greater interactivity between the subscribed actors, an integration with the data bases and PLM tools running in the Engineering and Design department would imply an easier access to an important volume of knowledge and the possibility of seeking and linking justifying documents in order to support the argumentative iterations during the popularisation phases of the conflict.

6 Conclusion

The product design actors today evolve in a context of strong interactions and sharing of knowledge. Conflict management therefore appears in this context as the most constrained form of collaboration. We proposed static and dynamic specifications of the CO²MED software solutions in order to handle conflict occurring in design. This work is embedded within the IPPOP project [25] whose aim is to provide a complete demonstrator integrating the product, process and organisation perspectives of design.

References

[1] Robin V., Rose B., Girard Ph., Lombard M. ”Management of engineering design process in collaborative situation”. Proceedings 14th International CIRP design seminar, 16-18 Mai 2004, Cairo, Egypt.

[2] Klein M., Dellarocas C., Bernstein A., 2000, Introduction to the Special Issue on Adaptive Workflow Systems, CSCW Journal, Vol 9 issue 3, pp 265-267.

[3] Monplaisir, L., 1999, An integrated CSCW architecture for integrated product/process design and development, Robotics and Computer-Integrated Manufacturing (15), 145-153.

[4] Girard Ph., Robin V., Barandiaran D.. Analysis of collaboration for design coordination. Proceedings 10th ISPE International Conference on Concurrent Engineering: Research and Applications, CE’03, 26-30 July 2003, Madeira, Portugal.

[5] Rose B., Lombard M., Gzara L., Lossent L., Claudon P.A., Leboeuf P., “Industrial Case of Product Design: Towards Specifications of a Collaborative Design Tool”, Proceedings of e-challenge 2004, Vienna, 27-29 October 2004.

[6] Thomas K.W., "Conflict and negotiation processes in organizations." In M. Dunnette and L. Hough (eds.), Handbook of Industrial and Organizational Psychology, 1992, pp 651-718.

[7] Wall J.A., Callister R.R., "Conflict and Its Management," Journal of Management, 21 (3),1995, pp 515-558.

[8] Barki H., Hartwick J., “Interpersonal conflict and its management in Information System Development”, Cahier du GReSI n°01-01, EHECM, 2001, Montréal.

[9] March J., Simon H.., Organizations, 1958, NY: Wiley, New York.

[10] Klein M., "Toward a systematic repository of knowledge about managing collaborative design conflicts", Proceedings 6th Artificial Intelligence in Design (AID'00), 2000, Kluwer Academic Publishers, pp. 129-146.

[11] Badke-Schaub P., Gehrlicher A., “Patterns of decisions in design: leaps, loops, cycles, sequences and meta-processes”, Proceedings ICED 03, 19-21 august 2003, Stockholm,.

[12] Schulz-Hardt S., Jochims M., Frey D., “Productive conflict in group Decision making : genuine and contrived dissent as strategies to counteract biased information seeking”, Organizational Behavior and Human Decision Processes, 2002, pp 563-586

[13] Rose B., Gzara L., Lombard M., “Towards a formalization of collaboration entities to manage conflicts appearing in cooperative product design”, in “Methods and Tools for Cooperative and Integrated Design” Tichkiewitch S. et Brissaud, D eds., Kluwer Academic Publishers. pp. 475-486.

[14] Matta N., Cointe C., “Concurrent Engineering and Conflict Management Guides”, Proceedings ICED’97, Tampere, August 19-21, 1997.

[15] Sigman S., Liu X.F., A computational argumentation methodology for capturing and analyzing design rationale arising from multiple perspectives, Information and Software Technology (45), 2003, pp 113-122.

[16] Taratoukhine V.V., Bechkoum K., Stacey M.K., “Conflict Management in E-engineering. The Methodology and Applications”. Proceedings International Workshop on New Models of Business: Managerial Aspects and Enabling Technology, 2001, St Petersburg State University, pp. 50-58.

[17] Dieng R., Hug S., MULTIKAT, “A Tool for Comparing Knowledge from Multiple Experts”. in M. L. Mugnier, M. Chein eds, Conceptual Structures: Theory, Tools and Applications, Proceedings 6th Int. Conference on Conceptual Structures (ICCS'98), August 10-12, 1998, Montpellier, Springer-Verlag.

[18] Golebiowska J., « Exploitation des ontologies pour la mémoire d’un projet Véhicule, Méthode et outil Samovar », PhD thesis, Sophia-antipolis University, 2002.

[19] Klein M., Supporting conflict resolution in cooperative design systems, IEEE Transactions on Systems, Man and Cybernetics 21 (6), 1993, pp 1379-1390.

[20] Simone C., Collective Memory from Everyday Work. In Y. Waern, 1996.

[21] Lombard M., Rose B., Ris G., “Design in collaboration: existing trends and application to the case of conflict handling with CO²MED software”, Proceedings 16th IFAC World Congress, 4-8 July 2005,Prague.

[22] Jardim-Goncalvez R., Olava R., Sarraipa J., Steiger-Garcao S., “Ontology-based framework for enhanced interoperability in networked industrial environments”, Proceedings

11th IFAC Symposium on Information Control Problems in Manufacturing, Salvador, Brasil April 5-7th, 2004.

[23] O'Leary D.E., "Using AI in Knowledge Management : Knowledge Bases and Ontologies". IEEE Intelligent Systems, 13 (3), May-June 1998, pp 34-39.

[24] Gruninger M., 2002, "Using Ontologies to evaluate knowledge-based Systems", PerMIS, USA.

[25] IPPOP Project, www.opencascade.org/IPPOP

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