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BUILDING A COLLABORATORY IN AN ENGINEERING R&D ORGANIZATION

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ABSTRACT

This paper presents the results achieved throughout the process of preparing the ground to develop a collaboratory in an Engineering R&D organization. This case study is part of a broader research project engaged in building a collaboratory in order to share knowledge and resources among the Portuguese State laboratories. In the process of preparing the ground to develop the collaboratory in the first of the laboratories studied, an information audit was conducted and an online survey was launched. The survey targeted 241 people, including mainly professional researchers, but also research trainees and some technical staff integrating the research teams. The questionnaire was designed so as to collect data on the organization's information management and information culture, and on the information flows taking place, and their relationship with the objectives of the organization. The questionnaire comprised two distinct and independent parts. The first (on the organization's information culture and information management) obtained seventy nine responses, while the second (information flows) achieved ninety two, corresponding to 32,8% and 38,2% of the total population, respectively. The work carried out provided the basic requirements for the task of developing a software infrastructure to support the collaboratory, addressing the various aspects of collaborative tools, information archiving, hierarchical tag classification, search, transparent integration of the user local environment with the platform and remote control of scientific instruments.

KEYWORDS

Collaboratory; Information audit; Information management; Information culture; Information behaviour.

1. INTRODUCTION

This paper presents the results achieved in the process of preparing the ground to develop a collaboratory in an Engineering R&D organization. This case study is part of a broader research project (Correia et al., 2007) engaged in building a collaboratory - understood as "a laboratory without walls, in which scientists are connected to each other, to instruments, and to data, independent of time and location" (Finholt, 2005:73) – in order to share knowledge and resources among the Portuguese State Laboratories.

The building of the collaboratory is anchored on three main tasks: a) information audits carried out in each of the target organizations, in order to map the main information flows, and systems used in each organization; b) information behaviour research, in order to gain insight into the organizational information culture and into the researchers' information-seeking and networking patterns, and to relate them to a number of factors, of an individual nature (such as education/degree or technical discipline), and of an organizational nature (tenure, role played and tasks performed); c) implementation of the appropriate infrastructure and tools, in order to accommodate information archiving and search, collaborative software tools, multi-channel access, common feel and familiar human interface, and open source software tools based on open source solutions, whenever possible.

The process of preparing the ground to develop the collaboratory included an information audit and the study of the organizational information management and information culture and of the researchers' information needs and information seeking. This last topic (researchers' information needs and information seeking) and the corresponding results are not addressed in this paper.

2. CONCEPTUAL FRAMEWORK

Scientific work is based on collaboration. According to Sonnenwald (2007:645) "*Scientific collaboration can be defined as interaction taking place within a social context among two or more scientists that facilitates the sharing of meaning and completion of tasks with respect to a mutually shared, superordinate goal*". Scientific collaboration has been historically associated with the sharing of common facilities, where physical proximity favours the quality and frequency of collaboration (Katz, 1994), and access to rare and expensive instruments is limited to those who use some unique facilities (Hagstrom, 1965; Traweek, 1992).

Collaboratories represent a potential transformation of the idea of laboratory (Finholt & Olson, 1997; Finholt, 2005; Sonnenwald et al., 2004). For scientists and engineers, collaboratories have the potential to revolutionize what they can do, how they do it, and who participates in what is being done. The capabilities provided by collaboratories are expected to increase the effectiveness of existing resources. Scientists and engineers become able to interact as if they were using the same physical location, sharing data, high-performance computing systems and instrumentation independently of location.

Nevertheless, Finholt (2005) warns that the benefits of collaboratory use may differ upon the status and experience of collaboratory users, and suggests that collaboratory use will augment, but not replace, proximity as a tool for fostering scientific collaboration.

Information auditing is a process of discovery, monitoring and evaluation of an organization's information flows and resources in order to implement, maintain or improve the

organization's management of information. In fact, information auditing can be regarded as a critically important information management tool, since it provides detailed and accurate information on the organizational information environment, and an understanding of the information management processes, at personal, operational, organizational and strategic levels (Buchanan & Gibb, 1998; Botha & Boon, 2003). Ultimately, the information audit aims at aligning the organizational information strategy with the organizational business strategy.

Information management can be defined as "*the application of management principles to the acquisition, organization, control, dissemination and use of information relevant to the effective operation of organizations of all kinds*" (Wilson, 1997:187), while the basic challenge in knowledge management is learning how to design an organization's strategy, structure and systems so that the organization can use what it knows to innovate and adapt (Choo, 1998).

Organizational culture derives from a shared set of values, norms and beliefs that shape the mental framework of the organization members and heavily influence their behaviour. That mental framework provides the lens to interpret the organization's external environment as well as the understanding of what is the right way to deal with whatever challenges are posed to the organization. Information culture, in turn, configures "*the socially transmitted patterns of behaviours and values about the significance and use of information in an organization*" (Choo et al., 2006:492). Consequently, it is the information culture that guides organization members in assigning significance to new information, and in deciding how to deal with it.

Wilson (2000:49) defines information behaviour as "*the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking and information use*". The ways in which information behaviour has been conceptualized and studied have changed profoundly over the last four decades. The most significant influences have been various strains of the sense-making paradigm as well as constructivist models of thought. At present, the dynamic, personal, and context-bounded nature of information behaviour seems to be largely acknowledged. Our rationale suggests that the individual information behaviour is influenced by the organizational information management and information culture.

The concepts we have briefly introduced are core to our conceptual framework and are closely intertwined. Information audit is a key information management tool, while information management is a key element in the configuration of the information use environment (Taylor, 1991) of an organization. On the other hand, information culture embeds the organizational values concerning the significance and use of information, and directly influences the information behaviour of organization members. We believe that all these concepts, and the corresponding organization features, must be taken into account in the building of a collaboratory.

3. METHODOLOGICAL APPROACH

The case study strategy was adopted because it is particularly amenable to the triangulation of methods (in this case, document analysis, survey and interviewing) thus providing rich ingredients to characterize a specific context. The research site is LNEC (Laboratório Nacional de Engenharia Civil), a large government R&D institution founded in 1946. Its main goals are to carry out innovative R&D in the various domains of civil engineering, to

contribute to the best practices in the field, and to give advice to the government in technical and scientific matters of civil engineering. The Laboratory has 650 staff (2007), of which 43% hold a university degree and 24% are researchers with a PhD or equivalent qualification. It also has about 80 research trainees with grants awarded by LNEC.

Our online survey targeted 241 people, including mainly professional researchers, but also research trainees and some technical staff integrating the research teams. The questionnaire was designed so as to collect data on the information management and information culture of the organization, on the researchers' information needs and information seeking, and on the information flows taking place. The part of the questionnaire addressing the organization's information management and culture incorporates the questionnaire used by Choo et al. (2006), with minor adaptations, since it was thought appropriate to replicate this study. The part of the questionnaire addressing information flows tried to relate these with the strategic objectives of the organization, to identify possible misalignments between information flows and strategy.

4. RESULTS

4.1 Profile of the Respondents

The questionnaire used in the online survey had two distinct and independent parts, one addressing the information culture and information management in the organization, and another addressing the organizations' strategic activities and information flows. The first obtained seventy nine responses, while the second achieved ninety two, corresponding to 32,8% and 38,2% of the total population, respectively. However, only the first part had a group of questions that allowed us to trace the respondents' profile. The great majority of the respondents is between 36 and 55 years old (73,4%) and is male (63,3%). Most of them (53%) are PhD or equivalent, mainly in the Engineering Sciences field, with particular incidence in Civil Engineering. Sixty-seven percent (67%) are professional researchers, while the remaining are research trainees and technicians. Seventy-six percent of the respondents work in the organization for more than ten years. We obtained responses from all the departments and from two of the three technical-scientific centres.

4.2 Information Audit

4.2.1 Alignment with Strategic Objectives

The information audit was designed as a three-step approach addressing the institutional level, the department level, and the individual level. At the institutional level, we interviewed members of the directive board in order to identify the main organizational processes and their alignment with the organization strategic objectives. At the departmental level, we arranged for a group meeting with the heads of each organizational unit to discuss, check and validate a model of "how the organization is viewed from the outside", which was prepared in advance based upon the results gathered from the first step, together with information publicly available about the organization. We also build an organizational "vocabulary" that includes the common types of information shared and their names, to use in the individual level

questionnaire. The survey was then developed on top of the results from these two previous steps. At the individual level, we used the survey to enquire researchers, research trainees and technicians integrating the research teams, to identify internal and external information flows, information sources and systems in use, perceived needs, and the alignment of tasks with those systems and flows, using the types of information names gathered in the previous levels.

One of the goals of the information audit was to analyse the correlation between the strategic activities and the actual work effort in the organization. We identified five strategic activities that were defined by the Laboratory's organization norms. These were: programmed research, studies, promotion of construction quality, dissemination of scientific knowledge, and cooperation with other entities. The survey enquired how much effort was dedicated to each of these strategic activities in order to assess the alignment between the effective work done by researchers and the organization mission and objectives.

We had ninety-two answers, and table 1 bellow allows us to draw several conclusions. Not all the strategic activities have the same weight in terms of work done in the organization. For example, more than half of researchers do not focus on the promotion of construction quality, and from those who do, their efforts are limited to 20%. This was confirmed by an analysis of the structure of internal information flows, where we saw a functional concentration of this activity in one specific department. This was a confirmation that information flows, and organizational structure are very much correlated. We can see that dissemination of scientific knowledge is a strategic activity done by more than 70% of researchers, although their effort is also not greater than 20%. We can also see that the two main strategic activities in terms of effort are programmed research, and studies, but their distribution differs. Forty percent (40%) of the researchers do not dedicate more than 30% of their time to programmed research, but in the case of studies, the distribution is much more spread out, with 10% of the researchers answering that half of their work is related to this strategic activity.

Table 1. Staff dedication to strategic activities

Percentile to choose from	Programmed Research	Studies	Promotion of Construction Quality	Dissemination of Scientific Knowledge	Cooperation with external entities
0%	21.7%	23.9%	54.3%	26.1%	31.5%
10%	8.7%	6.5%	22.8%	40.2%	45.7%
20%	20.7%	13.0%	12.0%	23.9%	9.8%
30%	26.7%	18.5%	6.5%	6.5%	3.3%
40%	9.8%	17.4%	1.1%	1.1%	4.3%
50%	3.3%	10.9%	0.0%	1.1%	2.2%
60%	3.3%	5.4%	2.2%	0.0%	2.2%
70%	4.3%	3.3%	0.0%	1.1%	0.0%
80%	2.2%	0.0%	1.1%	0.0%	1.1%
90%	0.0%	1.1%	0.0%	0.0%	0.0%
100%	0.0%	0.0%	0.0%	0.0%	0.0%

4.2.2 Perceived Systems Characteristics

The same survey also allowed collecting some information on the use of systems and applications within the Laboratory. Most, if not all researchers make use of common office applications together with specialized software packages for scientific computing, signal processing, simulation and control, etc. There are also several special-purpose databases. Researchers have frequently the need to share data among themselves and also to exchange

data with external entities. These needs expose several limitations of those systems as far as collaboration is concerned. Figure 1 lists the most recurring problems as reported by the respondents. About 45% of researchers complain about the systems being slow, and this performance issue seems to be the main problem. However, all the other problems being pointed out are effectively connected with issues that can negatively affect collaboration – the inability to export data, the need to support departmental activities, the lack of traceability and the lack of information structure are some examples of issues that must be addressed and overcome by a new information infrastructure to support the collaboratory.

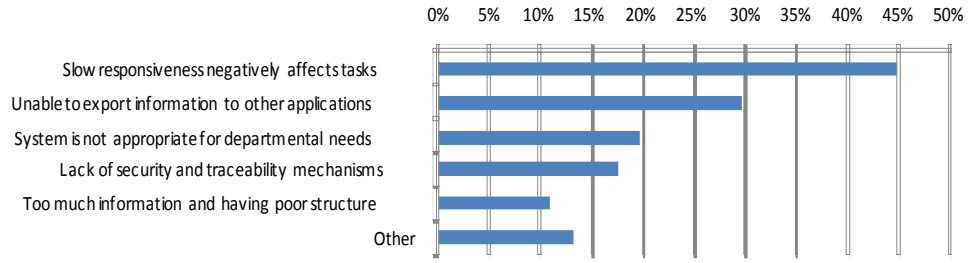

Figure 1. Systems characteristics

4.3 Information Management, Information Culture and Information Use Outcomes

4.3.1 Information and Knowledge Management

As mentioned before, our rationale suggests that the individual information behaviour is influenced by the organization information and knowledge management. Our survey envisaged to identify the perceptions of the respondents concerning key aspects in this area. Table 2 presents the mean scores of the items in both dimensions (IM and KM) of the variable "Information and Knowledge Management" (IKM). The mean scores show that the respondents tend to agree moderately with the given statements about information management in the organization (in a scale from [1] strongly disagree, to [5] strongly agree), although they seem to disagree with the statement "Information about good work practices and experts is easy to find in my organization". Generally speaking, the respondents agree more strongly with the items concerning knowledge management, even though they tend to disagree with the statement "My organization has formal procedures to collect and share knowledge".

Table 2. IM and KM descriptive statistics

	n	Mean	SD
Information management		3.15	0.697
My organization has a formal policy or strategy for managing information.	79	3.08	0.931
My organization identifies and obtains information from outside sources (e.g. government agencies, companies, universities).	79	3.49	0.918
In my organization information is available and organized in a way that it is easy to find what I need.	79	2.94	0.979
Information about good work practices and experts is easy to find in my organization.	79	2.78	1.058
My organization makes use of information technology to facilitate information sharing.	79	3.48	0.918
My organization has a culture intended to promote information sharing.	79	3.15	1.001
Knowledge management		3.39	0.764
My work unit encourages experienced workers to communicate their knowledge to new or less experienced workers.	79	3.61	1.103
My organization encourages workers to attend training courses and conferences.	79	3.52	0.890
My organization has formal mentoring programs and/or apprenticeships for beginning researchers.	79	3.41	0.994
My work unit has a culture intended to promote knowledge sharing.	79	3.49	1.048
My organization has formal procedures to collect and share knowledge.	79	2.91	1.028

This means that the research staff of the organization is moderately satisfied with the way information is managed in the organization, and slightly more satisfied with knowledge management. However, KM seems to be grounded mainly on person-to-person exchange processes, such as mentoring and apprenticeship, and less on formal organizational processes. This is consistent with the traditional way of doing things in the Engineering field, namely the relation established between senior and junior professionals, and the training and socialisation of new professionals. The collaboratory may help to implement more formal procedures.

The high values of the standard deviation for some of the items (table 2) led to further analysis. Additional crossings were made with the descriptive variables (gender; age; tenure; time in the institution; career) in order to understand what aspects might have influenced the dispersion.

Regarding the statement "Information about good work practices and experts is easy to find in my organization", some of the dispersion can be explained by tenure. More specifically, it appears that respondents who have a recent tenure have a largely neutral positioning. Those between 6 and 10 years' tenure strongly disagree, while those in tenure for 11 years or more agree the most. Also, respondents who are in the research career (professional researchers) tend to disagree more with this statement than the respondents in the technical career. It is also noticed that, respondents up to 45 years old, tend to disagree more with the statement, while older respondents have a more positive opinion.

The level of agreement with the statement "My organization has a culture intended to promote information sharing" seems to be influenced by age, since as we advance in the age group, the concurrence is more expressive and the uncertainty decreases, although the greater

degree of disagreement is located within the central age group. Also the difference in response according to gender is noteworthy. Women tend to disagree while men tend to agree.

4.3.2 Information Culture

The variable "Information Culture" is characterized by six dimensions or information values: integrity, transparency, sharing, proactiveness, formality and control (Marchand et al., 2001). Table 3 shows the mean scores of responses concerning statements about information culture (values and associated behaviours) on a scale from [1] strongly disagree to [5] strongly agree. The scores indicate agreement with all the items on integrity (if reverse-coded, the mean would be 3,57) and on transparency (with "Managers and supervisors of my work unit encourage openness" scoring the highest level of agreement: 3,67). The scores also indicate agreement with most items on sharing (with the exception for "I often exchange information with people outside my organization", scoring 2,99, but with the strongest agreement for "I often exchange information with the people with whom I work regularly", scoring 4,22), on proactiveness (with the exception for "My organization encourages workers to seek out relevant information on changes and trends going on outside the organization", scoring 2,89) and on control. As for (in)formality, informal information sources play clearly a subsidiary role in relation to formal information sources, which are much praised by the respondents.

Table 3. Information culture (values and associated behaviours) descriptive statistics

	n	Mean	SD
Integrity (reverse-coded)		2.43	0.893
Employees know what to do but not the ultimate goal of their activity.	79	2.38	1.054
Among the people I work with regularly, it is common to distribute information to justify decisions already made.	79	2.78	1.034
Among the people I work with regularly, it is normal for individuals to keep information to themselves.	79	2.58	1.205
Among the people I work with regularly, it is normal to leverage information for personal advantage.	79	2.33	1.152
Transparency		3.49	0.887
Managers and supervisors of my work unit encourage openness.	79	3.67	1.022
The people I work with regularly share information on errors or failures openly.	79	3.34	1.085
The people I work with regularly use information on failures or errors to address problems constructively.	79	3.46	1.035
Sharing		3.47	0.752
I often exchange information with the people with whom I work regularly.	79	4.22	0.872
I often exchange information with people outside of my regular work unit but within my organization.	79	3.34	1.108
In my work unit, I am a person that people come to often for information.	79	3.33	0.916
I often exchange information with people outside my organization.	79	2.99	1.068
Proactiveness		3.27	0.783
My organization encourages workers to seek out relevant information on changes and trends going on outside the organization.	79	2.89	1.109

I use information to respond to changes and developments going on outside my organization.	79	3.32	0.927
I use information to create or enhance my organization's systems, services, and processes.	79	3.59	0.899
(In)formality		2.70	0.769
I trust informal information sources (e.g. colleagues) more than I trust formal sources (e.g. memos, reports).	79	2.29	0.908
I use informal information sources (e.g. colleagues) extensively even though formal sources (e.g. memos, reports) exist and are credible.	79	2.53	1.048
I use informal information sources (e.g. colleagues) to verify and improve the quality of formal information sources (e.g. memos, reports).	79	3.28	1.061
Control		3.19	0.717
I receive information about the performance of my organization.	79	3.35	1.063
My knowledge of organizational performance influences my work.	79	3.10	1.139
In my organization, information is essential to organizational performance.	79	3.41	0.981
Information in my organization is distributed on a "need to know" basis.	79	2.91	1.157
Employees know what to do but not the ultimate goal of their activity.	79	2.25	1.006

These results suggest that this organization's information culture is characterized by a high level of integrity and transparency in the use of information, which is consistent with the ethos of an R&D organization. It is also characterized by formality in the use of information, and by the importance attributed to sharing information, mainly internally. These two last features may be explained by the large dimension and the unique role played by this government institute, which is a national authority consulted by government bodies on matters such as the location of the new Lisbon Airport, the feasibility study of the High Speed Railway (Rede Ferroviária de Alta Velocidade) in Portugal, or the development of the massive Alqueva dam. A closer analysis of the items on proactiveness reinforces the image of a somewhat inward-looking organization that uses information primarily to create or enhance the organization's systems, services, and processes, and less to respond to changes and developments going on outside LNEC.

We also tried to analyze more in-depth the causes for the high standard deviation values, namely in all the statements regarding Integrity. Still, we haven't found any relation between the descriptive variables and the agreement levels in the first two statements. However, in what concerns the item "Among the people I work with regularly, it is normal to leverage information for personal advantage", age and time in the institution seem to influence responses. The general level of agreement with the statement appears to increase as we advance in both groups. We also conclude that the item "Among the people I work with regularly, it is normal for individuals to keep information to themselves" appears to be slightly influenced by age (higher agreement among older respondents).

When examining the mean responses regarding Transparency, the results are very positive. Despite the somewhat accentuated standard deviation in all items, the observation of the distribution of frequencies showed that the responses are fairly consistent and uniform, pointing to a clear agreement with this set of statements. The degree of agreement with the item "I often exchange information with people outside of my regular work unit but within my

organization" varies depending on the time in the institution and on age (variables that are also related to each other). The disagreement is stronger at the lower end, while the respondents in the highest ranked group tend to strongly agree. That is, as the years pass, the exchange of information also tends to increase, which is certainly related to the creation of ties over time. It is also noteworthy that the same pattern occurs in the analysis of responses to the last item. That means, if in fact there exists some closure to the outside, this is particularly true among the younger generation. This may be explained by the fact that many of these are research trainees who, either do not have the autonomy to establish external contacts, or did not yet develop their own socio-professional networks.

About the items concerning Proactivity, only the first one generates a greater dispersion in the answers. However, the crossing with the characterization variables did not provide any clear explanation, and the same occurred with the two first items on (In)formality. Still, it may be worth noting that, given the statement "I use informal information sources (e.g. colleagues) to verify and improve the quality of formal information sources (e.g. memos, reports)", it appears that all respondents that fully agree are professional researchers.

Despite some dispersion, the first item regarding Control does not seem to be influenced by any variable in particular. For the second statement, the knowledge about the organization's performance seems to be more important as we advance in age. Given the statement "Information in my organization is distributed on a "need to know" basis" none of the variables of characterization helps explain the heterogeneous distribution of responses. Finally, faced with the assertion that "employees know what to do but do not know the ultimate goal of their activity", the variable that better helps explain the differences in behaviour is gender. We realized that women are practically the only ones who agree and that the proportion of those who disagree (either mildly or strongly) is much higher among men.

4.3.3 Information Use Outcomes

Information use "occurs when the individual selects and processes information which leads to a change in the individual's capacity to make sense or to take action" (Choo at al., 2006:495). Based on Taylor (1991), Choo et al. (2006) generated three categories that consubstantiate the outcomes of information use: a) task performance (includes the use of information to make sense of a situation, understand a problem or learn how to use a tool); b) self-efficacy (includes the use of information to sustain personal involvement, enhance status or reputation, or personal fulfilment); c) social maintenance (includes the use of information to develop relationships and get connected to others).

Table 4 displays the mean scores of respondents who indicate their agreement with five items about information use outcomes, on a scale from [1] strongly disagree to [5] strongly agree. The scores indicate a strong agreement with the three items concerned with task performance (with an aggregated mean of 3,65), a very strong agreement with the item concerned with self efficacy ("work benefits the organization" scores 4,01) and an even stronger agreement with the item concerned with social maintenance ("information sharing is critical…" scores 4,18).

Table 4. Information use outcomes descriptive statistics

	n	Mean	SD
Information use outcomes		3.83	0.526
I can solve the problems inherent to my work tasks.	79	3.95	0.749
My work tasks demand new, creative ideas and solutions.	79	3.97	0.816
My work benefits my organization.	79	4.01	0.670
I have influence over what happens within my work unit.	79	3.05	0.918
Sharing information is critical to my being able to do my job.	79	4.18	0.874

At this point, it is appropriate to remind that information use generates either a change in the individual's capacity to make sense or to take action. These results suggest that the research staff of this organization acknowledge that change occurs in these two spheres: changes in their capacity to make sense ("I can solve the problems inherent to my work tasks"; "My work tasks demand new, creative ideas and solutions") and changes in their capacity to act ("I have influence over what happens within my work unit"; "Sharing information is critical to my being able to do my job").

Given the acceptable values of the standard-deviation in this group, no further analyses were conducted.

5. THE COLLABORATIVE PLATFORM

The requirements for the collaboratory platform stem from the results obtained in the previous tasks of the research project described above, together with the critical analysis of products available for collaboration and the feed-back from the "hands-on" use of the first versions of the pilot platform. A set of requirements was iteratively consolidated, that shaped the development of the software infrastructure and tools for the collaboratory.

Besides the basic aspects of any integrated collaborative product, such as messages, wikis, chats, information archiving and general search, some more specific features were included in the context of R&D institutions. A system for the booking of experimental or computing resources was added, as well as the possibility of remote control of scientific instruments, as long as they are controlled by a computer. Some facilities of project management, such as milestones and related tasks, with delivery dates and deadline warnings are available. But the platform offers more specific features, some novel to the best of our knowledge. We implemented a hierarchical tag system, definable by the users, with an interactive interface, that opens several possibilities; it can be seen as a multiple "file system like" storage where a file, for instance, can be "in more than one place"; also, it allows for the classification with different hierarchical levels and orthogonal views of the objects stored in the platform. Another possible use of this mechanism is the definition of attributes of the objects handled in the platform, along the lines of a "dynamic database schema" without the restructuring of any underlying database. It should be noted that the hierarchical tags system is applicable not only to files but also to messages, chats, etc.

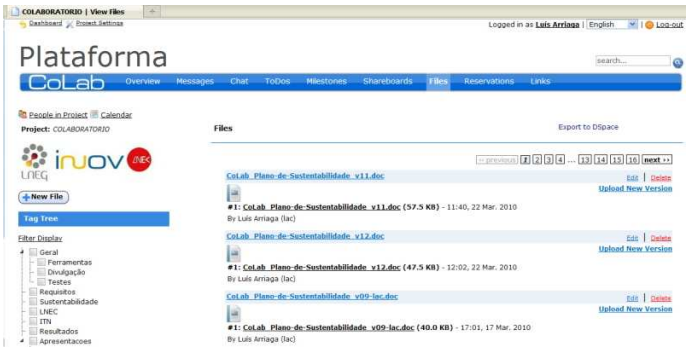

Figure 2. CoLab platform: file archive screen capture

Another feature that the platform implements, is the transparent integration between the users individual PC environment and the platform. Any action, be it for instance the creation or editing of a file is automatically reflected in the platform and therefore available to be shared with other users; this approach corresponds to a line of resource sharing based on the fast synchronization of "replicas" as opposed to a central "master" simultaneously accessed by different users. Some advantages are obvious: it is possible to carry on working off-line, the user can use locally, in his/hers computer the "best/favourite tool" to manipulate a file; some tools are only available in the home environment (e.g. graphic, numerical or CAD tools). The pilot platform is operational and being tested in "real life" situations. That is allowing us to better understand the usability and true merit of the various features, a task that is made easier as the platform logs all the activity carried out by the users for later analysis.

6. CONCLUSIONS

The information audit carried out in this Engineering R&D organization allowed to identify systems' features, as perceived by the respondents, which can negatively affect collaboration. The inability to export data, the need to support departmental activities, the lack of traceability and the lack of information structure are some examples of issues that should be addressed in the development of the information infrastructure to support the collaboratory. Information flows do exist, but they were not directly supported by software systems, dedicated to the task. The information audit also contributed with requirements to the collaboration software system, especially that it must be organizationally agnostic, because information flows are very dependent upon organizational structure, and to implement a specific structure in the software, is to restrict the ability of the organization to change.

The analysis of the researchers' perceptions concerning the organization's information management shows that the research staff is only moderately satisfied with the way information is managed in the organization. There seems to be ground for improvement in this area. In what concerns knowledge management, the research staff regards very positively the knowledge management processes based on person-to-person exchange, such as mentoring and apprenticeship, but is less satisfied with formal organizational processes of knowledge collection and sharing. The collaboratory platform and tools should help implementing more formal procedures.

On the other hand, the analysis of the respondents' perception of the organizational information culture reveals a culture characterized by a high level of integrity and transparency in the use of information, which is consistent with the ethos of an R&D organization. But it also reveals a somewhat inward-looking culture that we attribute to the unique role played by the organization. The collaboratory should provide the means to open up the organization and its community of researchers to external research communities.

These results helped us to consolidate a set of requirements for the development of a software infrastructure and tools for the collaboratory. This platform provides, in an integrated manner, the basic aspects of collaborative software, facilities for project management and resource sharing, but also implements more specific features, some novel to the best of our knowledge, such as a hierarchical tag system, definable by the users, that can be "seen" in several ways: multiple storage "file system like", classification with different levels and orthogonal views, ad-hoc definition of attributes to the objects handled in the platform. Also the platform implements a transparent integration between the users "home environment" and the platform; any action on a file is automatically reflected in the platform and therefore available to be shared with other users. This allows, for instance, to carry on working off-line, for the user to choose the "best tool" or use tools that are only available in the home environment. The pilot platform is operational and being tested in "real life" collaboration projects allowing us to better understand the usability of the various features.

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