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WEB-BASED MANAGEMENT OF RESEARCH GROUPS – USING THE RIGHT TOOLS AND AN ADEQUATE INTEGRATION STRATEGY

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ABSTRACT

Nowadays broad interest in a couple of interlinked subject areas can make the configuration of a research group to be much diversified both in terms of its components and of the binding relationships that glues the group together. That is the case of the research group for knowledge management and its applications to nuclear technology – KMANT at IPEN, a living entity born 7 years ago and that has sustainably attracted new collaborators.
This paper describes the strategic planning of the group, its charter and credo, the present components of the group and the diversified nature of their relations with the group and with IPEN. Then the technical competencies and currently research lines (or programs) are described as well as the research projects, and the management scheme of the group. In the sequence the web-based management and collaboration tools are described as well our experience with their use. KMANT have experiment with over 20 systems and software in this area, but we will focus on those aimed at: (a) web-based project management (RedMine, ClockinIT, Who does, PhProjekt and Dotproject); (b) teaching platform (Moodle); (c) mapping and knowledge representation tools (Cmap, Freemind and VUE); (d) Simulation tools (Matlab, Vensim and NetLogo); (e) social network analysis tools (ORA, MultiNet and UciNet); (f) statistical analysis and modeling tools (R and SmartPLS).
Special emphasis is given to the coupling of the group permanent activities like graduate courses and regular seminars and how newcomers are selected and trained to be able to enroll the group. A global assessment of the role the management strategy and available tool set for the group performance is presented.

1. INTRODUCTION

The ever growing scientific knowledge spectrum has changed the way science is done. More and more often, scientists from diverse disciplines are working together to solve problems in all areas. From health and biology to physics, mathematics, computing, engineering, social science etc, groups of scientists gather together to search for answers for a broad range of challenges that possibly could not be accomplished alone by none of them.

The hybridization of knowledge production has become a widespread and intensively debated issue within the scientific and academic communities. Funding agencies have special programs for large research projects that span several institutions, research groups and labs. The way scientists are trying to see the world nowadays is closer to the systems theory than to the object-oriented approach. The former presents a new epistemological perspective, where the understanding of the whole system at work – emerging behavior of interacting agents is preferred, rather than concentrate in functions and features of the parts alone.

A very illustrative example of the complexity found in some research fields is the World Health Organization Tropical Disease Research program. As reported by Kessel and Rosenfield [1], far-sighted medical doctors begun to realize that an effective delivery of health care need to involve sociocultural factors; besides health professionals, WHO also engaged local social scientists to help in the understanding of those factors to better delivery health care to developing countries population. “Together they developed and implemented projects that won over many of the skeptics inside WHO, in ministries, and academic social science departments.”

In Brazil, a landmark initiative that illustrates this theme was The National Institutes of Science and Technology Program (INCT) of CNPq (National Council for Scientific and Technological Development)[2].

Launched in July 2008, the INCT Program has become a powerful tool for promoting science, technology and innovation in the country. With 122 approved projects in different research areas, such as health, biotechnology, nanotechnology and energy, the Program aims to mobilize and aggregate in networks the best research groups in frontier areas of science and in strategic applications for the sustainable development of the country, as described in the PACTI (Innovation, Technology and Science Action Plan).

Looking at scientific publishing databases it's now rare to find papers written by lone authors. Instead, 4 or more authors are a common occurrence in scientific paper authorship. Researchers look for complementary knowledge more and more outside their own labs. Reasons may vary, but the set of expertise and cross-cutting experience necessary to succeed when searching funds for big research projects is easier achieved when collaborating with a large number of scientists from diverse disciplines, institutions, and, sometimes, from more than one country. Consequently, finding a long affiliation list in paper's authorship is very common nowadays.

While there is a growing acknowledgement that the world's complexity cannot be dealt effectively by a discipline-bound approach, there is also the realization that the production of discipline-specific knowledge has not lost its importance. The point is that effective teams cannot be made of specific sighted specialists and research managers. Specialists must have a good “know about” of their interfacing areas and research integrators must have a thorough “know about” of all the project involved areas and be proficient in problem formulation and system perspective. To cope with the complexity as well as with the agile development of today’s technology, scientists need to be well prepared to use an integrative, transdisciplinary approach.

The complementarity of discipline-specific and in a transdisciplinary approaches to R&D is well reflected in the following description of transdisciplinarity [3]:

> *Transdisciplinarity is nourished by disciplinary research; in turn, disciplinary research is clarified by transdisciplinary knowledge in a new and fertile way. In this sense, disciplinary and transdisciplinary research are not antagonistic but complementary.*

The driving force of modern "knowledge" society development seems to be more centered in quests and challenges originated in problem-based and application-based needs than science per science issues. The complex nature of today's problems, such as climate change, epidemiological surges, social pathology of large cities and resources scarcity at the global realm calls for transdiciplinary approach. The fact that transdisciplinary research starts from the premise that any problem or complex reality can be viewed and interpreted from a variety of non-equivalent perspectives and within each perspective a problem or reality can be understood from a range of spatial and temporal scales brings new kind of challenges to be dealt with.

Rigor, openness, and *tolerance* are the fundamental characteristics of the transdisciplinary attitude and vision. *Rigor* in argument, taking into account all existing data, is the best defense against possible distortions. *Openness* involves an acceptance of the unknown, the unexpected and the unforeseeable. *Tolerance* implies acknowledging the right to ideas and truths opposed to our own. (First World Congress of Transdisciplinarity, Portugal, 1994 *apud in* [1])

Working in a naturally multidisciplinary research field, the Research Group for Knowledge Management and its Applications to Nuclear Technology – KMANT at the Nuclear and Energetic Research Institute – IPEN, has found itself (intuitively) adopting the transdisciplinary approach to better study and interpret the knowledge management research field applied to nuclear area. As a consequence KMANT's research portfolio in is quite ample, and multiples disciplines are involved on several projects.

Another peculiar characteristic of KMANT at IPEN is the diversity of researcher locations; several research projects are developed by collaborators, scientists and non-scientists, working remotely from their home institutions or, sometimes, going to IPEN for specific research tasks only.

When working on research projects at KMANT, these collaborators can have several different roles – or links, e.g., there can be clients (stakeholders), consultants, suppliers, teachers, students, thesis supervisor etc. Also, the time availability and the strength of commitment of the collaborators can vary a lot and all of this has to be accounted for to carry out research projects and other group tasks.

As one can see management of the group and coordination of its research projects are not a simple tasks. Group members enroll for a variety of motives and after an observation period they start to participate in our activities, but it only after they have taken some graduate courses and have been tested that they become reasonably assured resources. Even though, most of them work in different institutions and are only part time (virtual) collaborators, and therefore, projects have to endure a lot uncertainties concerning dates and quality of deliverables.

To illustrate the problem at hand, we could describe KMANT as a network consisting of the following node types: people, institutions, projects, courses (graduate and short term courses) and seminars. In this network, people can be employees of IPEN or other organizations (the majority), full time students with or without fellowships, part time students and fellowship endowed research assistants. Their relationships with KMANT could be one

or more of the following: steady or sporadic collaborative research work, advisors, supervised students or simply courses/seminars attendants.

Besides these links between people, institutions will also have their on kind of connections. For instance, a institution can be partner in some project, client on other, supplier of something etc. Projects will also have connections, derived from their placement at the planning map of the KMANT research group. So a project can depend on other project's work, can provide data for or use data from other project, can do a further research or development on a previously finnished thesis or dissertation and so on.

Looking at KMANT Research Group through these lenses, it's easy to conclude that some care must be take to manage such a complex environment. This paper will show some of the strategic and management decisions that have been taken in order to cope with this challenge as well as our lessons learned from the trial and error improvement path we have been following.

The paper is structured into the following sections: description of the KMANT research group at IPEN, outline of the available/developing expertise, management issues and attempted solutions as well as the lessons learned and way ahead.

2. KMANT at IPEN

Knowledge Management (KM) has achieved remarkable prominence in the management forums and media in general. There are many enthusiasts supporters and practitioners in the business community, NGOs and international organizations. Research and Development (R&D) centers around the world have also intensively engaged KM practices, since such institutions are centered on the creation and use of scientific and technological knowledge.

Following on such worldwide interest, the International Atomic and Energy Agency (IAEA) promoted, in 2002, a meeting with its senior officials to discuss the subject. Attached to the invitation there was a introductory text stating: “Nuclear Knowledge Management is essential to warranty security and safety of nuclear facilities, leverage innovation, as well as to make sure all benefits of nuclear energy related to human health, food, agriculture, water management, electricity generation and a host of other applications, remain available for future generations”. In the same year, the IAEA General Conference adopted the resolution GC(46)/RES11B, asking the member countries to expand the efforts in this suject. In the following years this resolution was reiterated, showing IAEA commitment with KM.

The begining of the Knowledge Management and its Applications to Nuclear Technology (KMANT) Research Group at IPEN can be tracked back to 1999 with first studies and informal meetings on the subject. Following these initiatives, 2 graduate courses were offered at the Post Graduation Program of IPEN; these courses have had great audience and since then, several dissertations and thesis were concluded on knowledge management applied to nuclear area. All these good input were crucial to the decision, about 6 years ago, to formalize the Research Group, then with approximate 10-15 people.

KMANT Research Group has been kept together by the adoption of some Values and Principles, by stating a clear Mission, by having a sound Vision as well as by having a defined recruitement path. All of them must be followed by everyone entering the Group.

The Values and Principles are: a) Ethic; b) Availability and Commitment with the Group; c) Openess to novelties; d) To discuss and defend ideas but not vanities. The Group's Mission is stated as “Produce relevant knowledge through high-quality research and commitment to our reality; develop researchers and professionals to become more effectively "employable" and committed to the pursuit of excellence.”

Having its Vision expressed with the following words “Become one of the three most productive research groups of IPEN and be recognized by their peers at home and abroad”, KMANT has also adopted a recruiting strategy that include: a) Invitation or recommendation by some current member; b) Attending to regular meeting to confirm interest and affinity with the subject; c) Participating in some eventual group's task; d) Starts a selection process of theme within our Research Lines, considering the skills you have, or want to develop, and the own interest (passion for the subject); e) Attend the graduate courses indicated to our students; e) Through an iterative process, define the work plan for Master or Ph.D.

Trying to operate as a modern virtual organization the group has as its core business: teaching, researching, developing and get involved with practical application of the generated knowledge. Considering the environment in which the group is embedded, business has to be done through: a) operating in the client market of funding agencies, teaching institutions, companies, NGOs etc, where we seek for resources to support our research, placement of our products / services and search for new talents; b) Using channels such as journals, congresses, conferences, scientific meetings, notices of funding agencies, websites, blogs, social networks etc, to disseminate our activities; c) Offering short or regular graduate, undergraduate and extension courses, as well as distance learning courses, student advising, reports, papers, projects, on demand products and services, consultant, coaching, tutorials and so on; d) Organizing or co-organizing congresses, seminars, symposiums, and meetings on themes related wih the group vocation and competence; e) Evaluating our performance with productivity metrics that combine traditional academic merith figures with others focused on application and generation of knowledge value.

The KMANT Research Group has a dynamic approach to all this, illustrated in the Figure 1.

Our organizational design shows a grid of competencies and programs/projects, and our work model is network-based, through the web, with eventual face-to-face meetings. The group's organization is shown on Figure 2, where in the left column are the eight competencies that the group already have (or is developing/acquiring); they are described in more detail on next section, Expertises at KMANT. Also, at the upper row of Figure 2, are the several programs (or research lines) and below are the program's project portfolio – showing implemented projects (light blue) and latent projects (pink). Finally, the interconnections between all projects are shown as bold circles and denote the deep cooperation and transdisciplinarity character of our research.

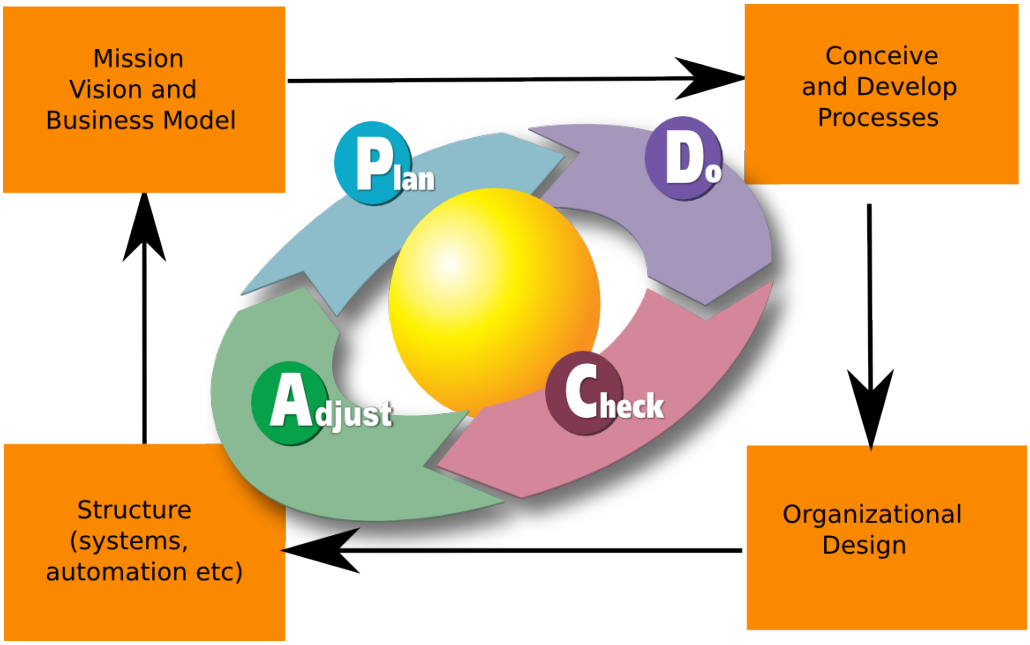

Figure 1 - Dynamic Operating Model of KMANT at IPEN

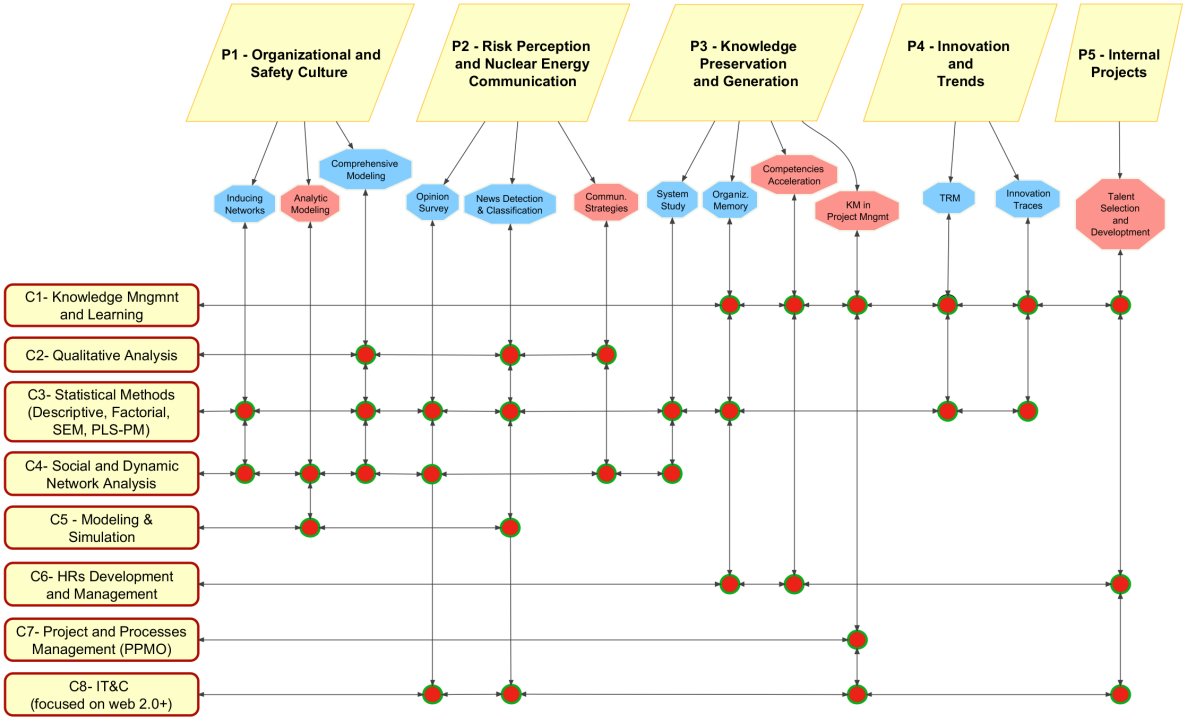

Figure 2 - Group's organization showing Programs, Competencies and Project Interconnections.

3. EXPERTISES AT KMANT

Over the years, KMANT Research Group has acquired several competencies that are the bases for the proper implementation of the Programs and Projects shown on Figure 2. These competencies along with some of the software tools mastered by the group are described following.

3.1. Competencies

C1 – References, Methods, Techniques and Tools of Knowledge Management.

Knowledge Management has a large spectrum of tools, methods, techniques and approaches. As a consequence of this great diversity, KMANT has focused its proficiency on those items most suitable and with greater potential for application at IPEN departments as well as at other nuclear organizations in Brazil. The following themes were selected:

- Techniques and tools for diagnosing and identifying knowledge gaps;
- Knowledge mapping, critical assessment and strategic alignment;
- Elicitation, dissemination and replication of best practices;
- Lessons learned and learning mechanisms;
- Collaboration spaces and communities of practice;

Some of the softwares used for this are: Cmap®, MindJet®, VUE®, LimeSurvey® and Visio®.

C2 – Qualitative Analysis

Part of the research done at KMANT is qualitative research, characterized by a descriptive, analytic and interpretative approach. This kind of research is based on the assumption that some data types can not be put in numbers. Rather, they must be interpreted and their meaning must be attributed by the investigator. No statistic technique is suitable and specific methods are used.

On of the main instruments for qualitative research are the questionnaires. For questionnaires administration we have used the software LimeSurvey®.

C3 – Methods and tools of descriptive and multivariate statistics

As much of our research is comprised of data bases obtained from questionnaires and interviews, we have had to master several statistical techniques, such as: statistic tests, cluster analysis, principal component analysis etc.

Some of the softwares used for this are: Minitab®, Matlab® and R.

C4 – Social Network Analysis

Social Network Analysis (SNA) is a powerful tool to assist in understanding how tacit knowledge propagates and how central elements of organization's culture are created,

modified and consolidated. KMANT has great expertise on the SNA techniques, such as: snow ball type survey to map networks; global network indicators; local indicators; centrality; spectral analysis; cluster analysis (cliques, plexes etc) and others.

Some of the softwares used for this are: UciNet®, NetDraw®, MultiNET®, Pajek®, ORA®, Agna®, R etc.

C5 – Modeling and Simulation.

This competence is in an early development stage; it will be largely used to simulate behavior diffusion and assimilation as well as organizational culture; we'll also investigate the impact that distinct policies can have to instigate or improve desirable behaviors.

Some of the softwares used for this are: Matlab®, Vensim PLE® and Netlogo®; Python programming language can also be used.

C6 – Human Resources Development and Management

This competence is also in an early development stage; right now, it will be used in connection to Knowledge Preservation and Generation Research Program – P3 in Figure 2. There are two student project proposals associated with this competence.

C7 – Project and Processes Management (PPMO)

As KMANT is trying to operate like a small consultant office, is very important to have a well defined strategy for all project and process management. This competence, that is in an initial stage, will fill this gap, allowing for a more professional approach to the internal issues of managing a research group.

C8 – Information Technology and Communication

This competence is related with all computing infrastructure available at KMANT. It involves server administration, maintenance, upgrading and fixing policies. There is also software competence, related to all available computer programs, tools and libraries used by all KMANT members while working at IPEN computers.

Most server softwares used at KMANT are Free Software; the operating system for all external web accessible systems is Debian/GNU Linux; e-Learning platform is Moodle[6]; Project Management software is Redmine[7] and Web Portal is based on Plone Content Management System[9].

On the desktop, KMANT has used and mastered some softwares as well:

- Cmap – a concept mapping application. Developed by the IHMC (Institute for Human and Machine Cognition), Cmap is a powerful tool in knowledge representation and capture.
- VUE – an Open Source project based at Tufts University. The VUE project is focused on creating flexible tools for managing and integrating digital resources in support of teaching, learning and research. VUE provides a flexible visual environment for

structuring, presenting, and sharing digital information. Largely used as a concept mapping tool at KMANT or at project discussions meeting.

- ORA – a dynamic meta-network assessment and analysis tool developed by CASOS at Carnegie Mellon. It contains hundreds of social network, dynamic network metrics, trail metrics, procedures for grouping nodes, identifying local patterns, comparing and contrasting networks, groups, and individuals from a dynamic meta-network perspective.
- R – a free and powerful software environment for statistical computing and graphics[8]. With more than 2000 contributed packages, R provides facilities to almost every statistical necessity of KMANT.
- LimeSurvey – an open source survey administration platform that allows users to quickly create intuitive, powerful, online question-and-answer surveys that can work for tens to thousands of participants without much effort. The survey software itself is self-guiding for the respondents who are participating.

4 – MANAGEMENT ISSUES AND ATTEMPTED SOLUTIONS

The coordination challenges and issues that have to be faced to carry over the group's activities it is better appraised when one observes the operational environment shown in Figure 3. The inner core of group consists of the group leader and three other researchers that dedicate a fair amount of time to the group (from 20 to 30 hrs./week each). Then there is a variable sized layer of two to five collaborators that are IPEN employees allowed to spend from 30% to 50% of their working hours for their thesis work, or students endowed with scholarships / fellowships from scientific initiation to doctoral students, depending on the opportunity. A third layer of part time students that are working on dissertation and thesis projects within the group's themes. A fourth layer of external researchers and professors that eventually collaborate in some of the group's activities. Finally there is a layer of students that are either taking graduate disciplines ministered by one of the core members or coming to the group's seminar activities.

Looking to the group as a network there are nodes whose frequency of interaction is very low, but it is very important to spread knowledge and novelties awareness among the group members. For this purpose the group has a web portal and a program of seminars.

The seminars are intended to give those doing research in the group to present their ideas, progresses and difficulties and by doing this everyone gets to know who knows what. The program normally schedule 12 to 15 events per year, and invited speakers take the stage on 3 to 5 of them. In this way cross fertilization of ideas is promoted and excessive endogenic thinking is avoided.

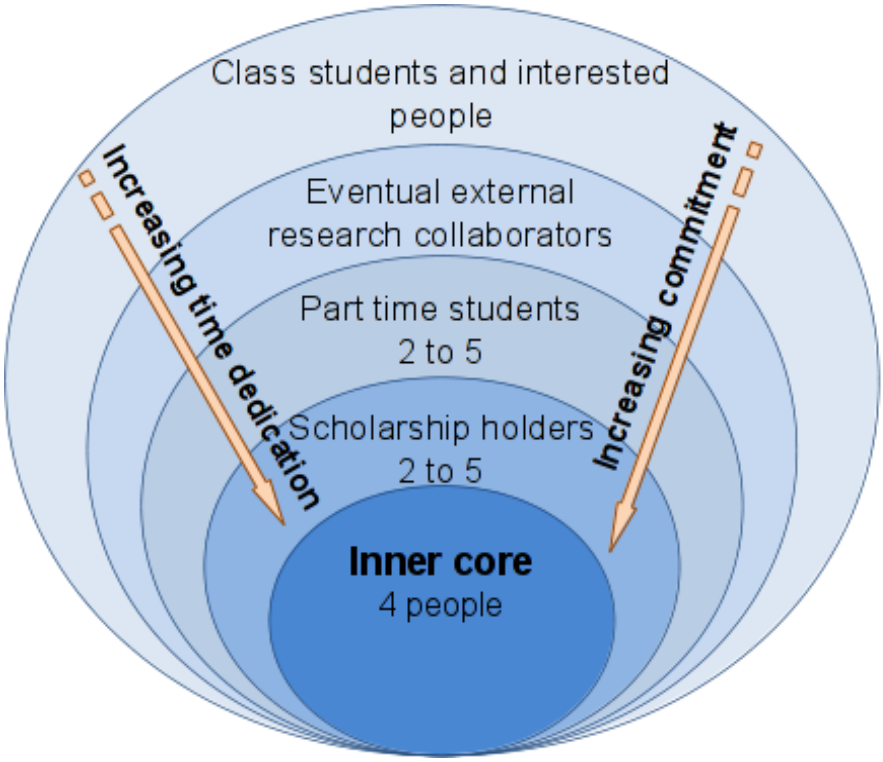

Figure 3 - KMANT Operational Environment

The web portal (http://gescon.ipen.br) has multiple purposes as can be noted from the description of its Sections:

- News – section used for public announcements.
- Events – group's calendar, showing all seminars and other events promoted by KMANT.
- About Us – this section briefly describes KMANT: a short historical perspective; Principles and Values; Mission; Vision; Enrollment instructions for those interested in participate.
- Competencies – this section outlines the KMANT Competencies, very close to the description gave above on section Expertises at KMANT.
- Resources – this sections makes available some of group products: seminars slides; short term courses material; publications (dissertations, thesis, articles etc.); opportunities advertisements; journals, conferences and other publication targets; other types of resources produced by KMANT like softwares, libraries etc.
- Special Sections – this sections are reserved for special purposes. Currently there is one of such section: INCT (National Institutes of Science and Technology Program) of CNPq (National Council for Scientific and Technological Development). In this section of publish some of the results of KMANT participation in one project – INCT of Advanced Nuclear Reactors.

- Internal Matters section – there is a special section only accessible by KMANT members, after a membership application and approval. This is used to keep members up to date with important themes inside KMANT.

In spite of the effort done so far, the portal has not yet acquired a dynamic personallity. Much of the content is being updated only occasionally and by one or two members.

As part of KMANT strategy for dynamizing the web portal, a set of tasks are being prepared and will be assigned to all KMANT members, so that sections or section-parts will have someone responsible for content provisioning or updating.

It is a fact that most of the collaborators of layer 2 and 3 got their first contact with the group while class students (layer 5); therefore it is recognized as a good opportunity to indoctrinate them with the group's research themes and way of working, while they are taking the courses. For such purpose, even though all graduate disciplines at IPEN require physical presence, for the group core disciplines, Moodle[6] is used to supplement the classes with chats, blogs, forums for after classes doubts elucidation and a knowledge base with reading texts, articles and so on.

Also for these disciplines, course projects to be carried on by teams are required. These projects are usually put in the form of problem description and expected results by the professor to which the assigned team has put a project proposal with well specified project plans and deliverables. Students are encouraged to use Redmine[7] - a web-based project management tool that it is available for their use in the group's server.

During the courses, students also have to do some homework using software that are used very often in the group activities, e.g. Cmap, VUE, FreeMind and ORA. In this way they get more prepared should they apply to enroll the group later on.

From March 2011, it was decided that each new master or doctoral research work should be formatted as a project and formalized in the Redmine[7], using a Scrum like approach. Sprints of 15 days and a month should be, respectively, adopted for masters and doctoral work plans. The advisor will play the role of project owner and the candidate (student) a double role of manager and developer. Other researchers of the group (including the advisor) can also play a supporting role when the candidate needs help to solve issues that he does not know how to deal with. It is made clear that candidates have the right to access these knowledge resources (group members) and they have to show that they have learned to deal with those issues through the progress results of his/her work.

5. LESSONS LEARNED AND THE WAY AHEAD

Managing a research group with a fluid structure has been at the same time an enlightening pleasure and a challenging learning experience. A lot of experimenting, i.e. trial and error, have been done. This is viewed as a very good way of approaching practical problems and one that can produce very good solutions; the results obtained at each trial are evaluated and evolved to be used in the next best fitted variant. Tim Hartford [4] states that people should

avoid the “god complex”, i.e. “people who, in the face of an incredibly complicated world, are absolutely convinced that they understand the way that the world works. The world is simply too complicated to be understated in this way”. Instead of trying complicated solutions for complex problems, a more humble approach should be taken based on trial error. Moreover he says – “show me should be a successful complex system and I will show you a system that evolved from trial and error”.

For an outside class learning platform Yahoo groups were used during the first two years that the Knowledge Management disciplines TNA5773 and TNA5776 (see IPEN site at http://www.ipen.br/sitio/?idm=276). From 2004 to 2008, PhProjekt [5] was used with relative success and despite the fact that it is not a distance learning (DL) platform it has the most needed features. Also from the lecturer point of view, dealing with the platform was more straightforward than it is with Moodle [6] in the sense that requires less mouse clicks to perform the tasks. At that time PHProjekt lacks cosmetics and the Portuguese language presentation was very poorly translated. By 2009 a decision was made to switch to Moodle learning management system (LMS), not because of lack of functionality in the previous platform, but partly because Moodle was designed from start to be a learning environment and principally because there is a very large community of Moodle users. In terms of flexibility for users (professor and students) PHProjekt has a easier interface. It is our feeling that with the right plugins and a student willing to do master work in personalizing Moodle for our expectations we can to have a near optimum platform for our purposes. Anyway for next year, an internal group project will be launched to deliver such long desired platform.

At the beginning of KMAN (2003 to 2007), it was difficult to find students to pursue research themes of our interest. They were mostly part time students that want to match their professional competency demands with their research work and a lot of compromising was required to find a theme and research work track acceptable for both parts. At that time we used to say that we were advising students on a retail basis, because the themes were very diverse but without a central coherence to have synergy among them. As we become better known within IPEN and USP graduate student communities, we start to offer research work themes from our portfolio, depicted at Figure 2. This approach brought a consistent foundation for KMANT research lines, allowing for the deepening of some areas as well as for the broadening of others.

One the main lessons we have learned over these years is that the trial and error approach can be effectively used in the management of research groups once the leadership consciously choose it. To learn with one own errors and improve on the next trial is a continuos exercise. No one can safely say has achieved a perfect state when managing research groups.

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