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THE DESIGN AND DEVELOPMENT OF AN E-RESEARCH CENTRE FOR MECHANICAL ENGINEERING SCIENCE

Sorin BORZA, Nicolae COFARU

"Lucian Blaga" University of Sibiu, Faculty of Engineering Emil Cioran, No. 4, Sibiu, Romania, sorin.borza@ulbsibiu.ro, nicolae.cofaru@ulbsibiu.ro

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Abstract The peper is meant to set up an e-research center for the researchers in the field of mechanical engineering sciences as well as its development and integration in the existing national and international infrastructure using GRID networks. The goal of this center is to include as many researchers from our faculty initially, then from our university, our geographic area, our country, from all over the world. To this purpose, the center sets itself to promote and support new e-research projects, to encourage the building of multidisciplinary groups that should cooperate among themselves and share resources and infrastructure.

1. INTRODUCTION

The paper sets itself to approach a less developed interest field in Romania, namely Internet research or e-research. Bibliographical references testify to the existence of a major interest regarding e-research in developed countries such as Great Britain, the United States of America, Japan, Australia, and an important development of its technologies relating to it in the coming years. Cyberinfrastructure which represents the basis of this interest field will become one of the representative technologies of the 21st century.

Research is a human process that manifests itself differently at a certain age. The Cambridge dictionary defines research as "a detailed study of a subject that is aimed at discovering new information and understanding new meanings about an entity." The use of the Internet adds intrinsic values in order to increase the quality of research. The Internet can offer new opportunities for increasing the quality of research and for introducing new problems and challenges. The Internet contains a medley of data. In general, e-research helps us convert data in information and disseminate this information along channels that allow their transformation into knowledge and information by researchers for their sponsors and the public at large. The quantity of information associated with the speed at which it may be accessed, filtered, sorted, leads to various opportunities. E-research is more than a set of new research techniques. The Internet researcher may be considered a web component. Web researchers design and create tools for the analysis and conceptual understanding of the human environment. In many cases the e-research scientist is the external assessor and in a different context he can be both practitioner and researcher. The researchers are members of the Internet communities; thus they introduce their knowledge and experience through Intranet links either individually or collectively. E-research has its place beside e-commerce and e-learning. It is a new way of understanding and building information in the current society that uses network technologies. E-research introduces new tools such as "asynchronous voice conferencing" and "video capture" that allow a complete multimedia interaction. Moreover, e-research uses distributed data and data processing capacity on the Internet.

Cyberinfrastructure is an essential concept on whose basis e-research is developed. One of the most important organizations in this interest field is NSF (National Science Foundation). One of the main aspects pointed out at the last NSF conference entitled

"Cyberinfrastructure Vision for 21st Century discovery" in January 2006, was "the national and international, public or private partnership, which integrates CI (computing information) users and which academic communities and researchers affiliated to NSF can benefit from. Ardent Bement, manager of NSF, stated in his speech that Cyberinfrastructure would allow exploration of new horizons for research and education.
Researchers can now study the ways in which students can learn online or in which online education allows decision making or runs businesses. These interest fields are not accessible to the researchers who are not connected to the Internet. We are positive that the network societies are not a whim and that we are at the beginning of a new era of the human activity. The computer network has now become an essential component for many activities, so that it is inconceivable to use tools that are not part of a network. Moreover, it has become very clear that the new ways of patterning and communication cannot exist without a computer network. That is why the goal of e-research is to extend these entities to new levels unattained yet.

2. THE ACTUAL KNOWLEDGE STAGE IN THE E-RESEARCH AREA

The centre will offer original elements in the field of e-research in direct connection with other concepts such as e-Science, Cyberinfrastructure, Grid Computing. According to the information taken over from the University of Queensland, The School of Information Technology and Electrical Engineering (ITEE), The Computer Expert Science Group (February 2006), the e-research support services responding to a challenge facing the South African research and information communities (Hammes, R.J., Reagon, H., Thomas, F., Ed. M.J. and Veldsman 2005), several models have been devised in the developed countries on an international level, that have as a goal the development of scientific research based on the previously mentioned concepts. There are several models for an e-research system structure.

The model developed in Great Britain is the most efficiently focused on international initiatives. It is made up of three main components:

1. The Open Middleware Infrastructure Institute (OMII);
2. A Grid Support Center (GSC);
3. Regional centers.

OMII and GSC work together to assist the purchasing, coordination, development, and integration of the program depending on the requirements of the e-research community. They support the pilot projects of the researchers in the local areas that use Middleware products and the GRID network. All tools and resources provided by OMII and GSC are used by the regional centers.

Three important initiatives have been developed in this field in the USA:

1. NSF Middleware Initiative;
2. Internet 2 Middleware Initiative
3. DOE Science Grid

Alongside of these initiatives, there are several important projects such as:

1. NASA Information Power Grid;
2. Grid Application Development Software, etc.

In accordance with the information existing at NSF Advisory Committee for Environmental Research and Education. 2003.*Complex Environmental Systems:Synthesis for Earth, Life, and Society in the 21st Century.*A report summarizing a ten-year outlook in environmental research and education. Arlington,Va.: National Science Foundation. 68 pp.

http://www.nsf.gov/geo/ere/ereweb/acere_synthesis_rpt.cfm, NSF Blue Ribbon Advisory Panel on Cyberinfrastructure. 2003. *Revolutionizing Science and Engineering through cyberinfrastructure.*Arlington,Va.: National Science Foundation. http://www.cise.nsf.gov/evnt/reports/toc.htm NSF Middleware Initiative (NMI) appeared in 2001 to define and develop a Middleware infrastructure on a national level. One of its main goals is to explore the ways in which the e-Research concept can be introduced in student hostels. NSF has also founded NMI Integration Testbed made up of eight universities that evaluate NMI together. The testbed sites use and assess the software, services and architecture that grant access to the electronic resources for faculty and campus projects.

Internet 2 Middleware Initiative (12-MI) is a consortium made up of 206 universities that work in partnership with the industry and government in order to develop advanced applications in a network. Every sector of activity has a manager who is responsible for the actions in his own field of activities.

The guiding principle of DOE (Department of Energy) Science Grid is to build a type of cyberinfrastructure with certain standards of permanent users who are on the DOE projects. This information can found in:

The EGEE (Enabling Grids for E-Science in Europe) project aims at integrating national, regional or topic area Grid efforts with a view to building a unitary Grid infrastructure for e-Science research. This infrastructure will be built on the basis of European Research Network EGEE sets itself to use and coordinate the existing national programs without replacing them. The project has two important aims:

- To discover the Grid levels, their essential elements which are ductility, endurance, resistance to destructive factors and a strong security system. Scalability is equally essential for rapidly absorbing new resources and for ensuring a viable long-term infrastructure;
- To harness a strong effort in the training activity which can direct the GRID services towards new communities of researchers in the academic or industrial milieu. This will entail further clarification in the field of e-Science.

In order to secure an efficient management the European Grid community is divided into ten regions: CERN, Central Europe, France, Germany/Switzerland, Ireland/UK, Italy, Northern Europe, Russia, South-East Europe, and South-West Europe.

Japan prides itself on The National Research Grid Initiative (NAREGI). This is a project launched by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan in 2003 that contains a significant number of grid initiatives. With a budget of 17 billion $ and an execution period of five years (2003-2007) this project addresses mainly university professors and aims at building research centers among universities; for example, the National Institute of Information Technology (NII) and the Institute of Molecular Science (IMS). NAREGI is not a project that develops grid products. It is directed at developing certain projects in various fields such as simulations in the science of materials, nanotechnologies, chemistry, etc.

Information concerning the concepts of this field as well as it dynamics can be found in specialized literature and journals such as:

There are significant projects related to the Grid network development in the country, in the university centers of Bucharest, Cluj, Timşoara, Iaşi, Craiova. The latest achievements in this field have been presented at the National RoGrid Conference in March 2006, in Bucharest.

3. THE IMPORTANT ASPECTS OF THE E-RESEARCH CENTRE

One of the most important aspects of the center from a scientific point of view is to develop proper working conditions for research. First of all, an investigation will be carried out of groups in the university, of the operating grids, and the possible development of an existing one. The center will connect all the existing organizations in a grid. Thus, the resources will be created to bring together into a single whole all the constituents of research, in the first instance at faculty level and then at university level.
Access to the latest scientific information via the links with e-research communities worldwide has become a fact. The members of the center can:

- become active members of the e-research community in the country;
- become members of standard international programs (GGF, OASIS, etc.);
- Participate in e-research conferences in the United States and Great Britain (NSF Cyberinfrastructure activities, NSF Digital Libraries, UK e-science workshops);
- set up links with international research centers such as UK e-Science Centers, US's Argonne National Laboratory, San Diego Super-computing Center (SDSC) and The National Center for Supercomputing Applications (NCSA at the Illinois University)

The scientific importance of the centre results from the following aspects, too:

- devising courses and software training with applicability to the fields of mechanical engineering;
- developing a software distributed for improving research;
- developing distributed data bases that should contain important information from a scientific point of view;
- organizing high quality seminars and courses for both full-time and distance learning courses;
- ongoing postdoctoral research of the team members that hold a Ph .D. in engineering;
- supporting doctoral programs for other team members;
- improving equipment and software with a view to developing high quality scientific research;

4. THE E-RESEARCH CENTRE PRESENTATION

The topic of the centre fits very well in the priority field: Information and communication technologies, meant to open new horizons of knowledge and to implement applications in the field of research and education;
Implementing the results:

- building an e-research center in the field of mechanical engineering as well as drawing up the explanatory materials and the knowledge tests in the field;
- developing the conceptual-theoretical and methodological frame of the information and communication technologies;
    - building new instruments and technologies for specific applications;
    - providing compatibility requirements for Romania's integration in the socio-economic European environment, defined through the knowledge society and "e-Europe";

The research fits the topic interest areas, meant to develop Internet communication networks, to use active learning solutions and advanced systems of research both in the academic and production milieu. Less explored areas as well as limitations of the approached topic can be detected from the analysis of existing information:

- e-research does not relate to a specific field, but, possibly, to instances of use and operation of these;
- formal limitations may appear: research is not proper to learning by discovery but rather by reproduction and changes are necessary for a proper use;
- the concept of e-research is not used in the proposed topic area;
- access limitations, given by the lack of logistic support (computers, the Internet, specific teaching aids).

Therefore, the program suggests elements that should surmount part of the reported limitations. The centre will include the following components: data mining, huge amounts of data, instruments for data manipulation, high capacity networks, high quality computers. The e-research centre will develop the following activities:

- it will generate accurate research data for experiments, observations or simulations;
- it will develop and explore models and simulations and will make possible scale limit data calculations;
- it allows virtual distribution of organizations assisting cooperation between researchers and industry by sharing the resources;
- it provides instruments for security ensurance and information flexibility.

The specific fields in which this e-research centre will operate will be the verify of geometrical specifications (GPS and the integrated systems of production.

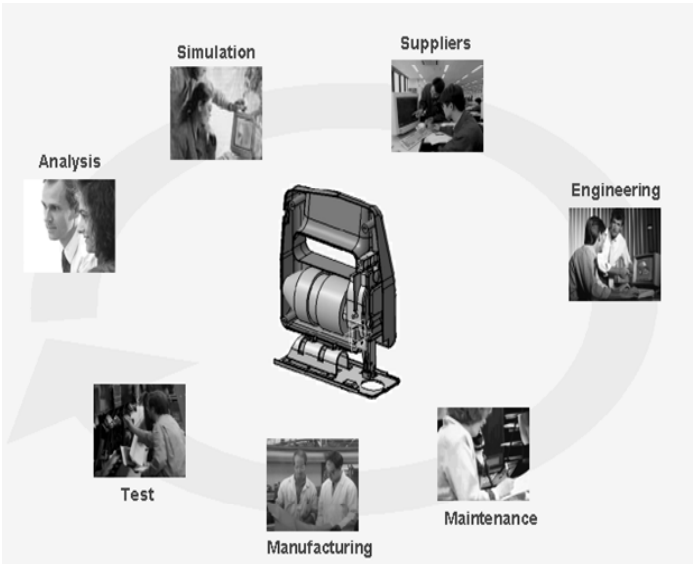

Figure 1: The PLM concept

Multidisciplinary team work on the Internet by using specific ways and methods is essencial in the integrated
systems of production, where integration with the help of electronic ways used for calculation of the domains
CAD/CAM/CAQ is dominating. Applying the concurrent engineering waystands methods, the teams realise common projects by the superposition of some activities which lead to the achievement of some reduced livration terms and on this way the productivity of some speciffic activities will rise. Using the PLM concept – Product Lifecicle Management (figure 1), the activities from the products designing domain and technologic process, the ones from the analysis domain and optimisation with the method of finished elements, theones from the fabrication domain and the ones from the mentenance domain are conducted threw SMARTEAM and ENOVIA modules that work together with CATIA V5. The program pack AUTOFORM and DELMIA is used for the operation and products checking and

simulation. The first one realises the operations optimisation at the pieces of sheet for cars industry and the second realise the mechanical working operation simulation on the tools cars with CN.With the help of Internet facilitie the teams work situated at a distance can communicate and realize a project that includes the projecting-analysis-fabrication-logistics, threw manipulation not only of the alfanumeric data files (technological dates, business data) but also graphic dates from the databases. The access to different programs is made on access levels and at the same time with these utilisations there can be made a making topical of the databases. E-Research in the mechanical engineering domains allows the achievement of a competitive product, but also the implementation of technological modern process for its fabrication.

Each engineer that is involved in designing or manufacturing process must have some knowledge on specifications concerning the geometry of product and the requirement to verify (test or measure) the pieces. Without such competence neither creating new technical documentation nor its reading and construction is possible.

The set of requirements concerning geometry of a product is known as *Geometrical Product Specifications (GPS)* covering requirements on sizes and dimensions, geometrical tolerances (of form, orientation, position and runout) and geometrical properties of surface (surface roughness).

Today, GPS can be found in nearly all manufacturing industries, from the very small geometry found in integrated circuits to the very large geometry found on rockets, the space shuttle and the international space station.

Generally, GPS assure obtaining some essential properties of the product: functionality, safety, dependability and interchangeability. It is also reinforced by the needs of rapidly expanding CAD/CAM/CAQ marketplace that placed a high premium on mathematical formalism so that reliable and compact software can be developed to support computerized applications in these areas.

Bases of Geometrical Product Specifications and related metrology (verification) should be a part of mechanical engineer education. Some components of such a training program are:

- general information on GPS – standardisation and application in quality management;
- systematic review of different cases of tolerancing, including their theoretical background;
- calculation of tolerances applied in design and manufacturing;
- inspection problems (measurement equipment requirements; how will the part be inspected? what tools will be used?);
- applications.

With proper training and implementation, GPS will help every company to reduce scrap, increase the percentage of usable parts, simplify inspection and assembly, replace fewer parts, avoid recalls, increase efficiency and give the edge over the competition in today's cost competitive marketplace.

Moreover, courses and training will be initiated in this field. Researchers in the academic milieu, in industry, doctoral students, Ma students, students will be involved in the research activity. E-research, e-Science, cyberscience, cyberinfrastructure are terms that refer to the scientific effort developed on the basis of ICT (Information and Communication Technology) using a huge amount of data. The relationship between the e-research center with other existing infrastructures will have as effect the development of new research paradigms, with new scientific methods there being no danger of parallelism among them on an international level. The e-research paradigm is dependent upon a support service or cyberstructure that includes the following elements that are necessary for collective work in an integrated system, that should have the necessary security system as well as the

ways of access allowed:

- computers, supercomputers, working points;
- database memorization support;
- infrastructure for data transmission;
- computer networks;
- digital libraries with metadata necessary for a large number of prospective users;
- software (operating systems, middleware, support-platform for the development of applications);
- services (education, training, counseling, assistance for users);
- access to specialized literature on an international level.

The software program that will be developed within the project for the dimensional control and fabrication systems, will use the working algorithm as shown in figure 2.The working stages that will represent part of the proposed objectives and activities try to surmount the limitations of the current stage.

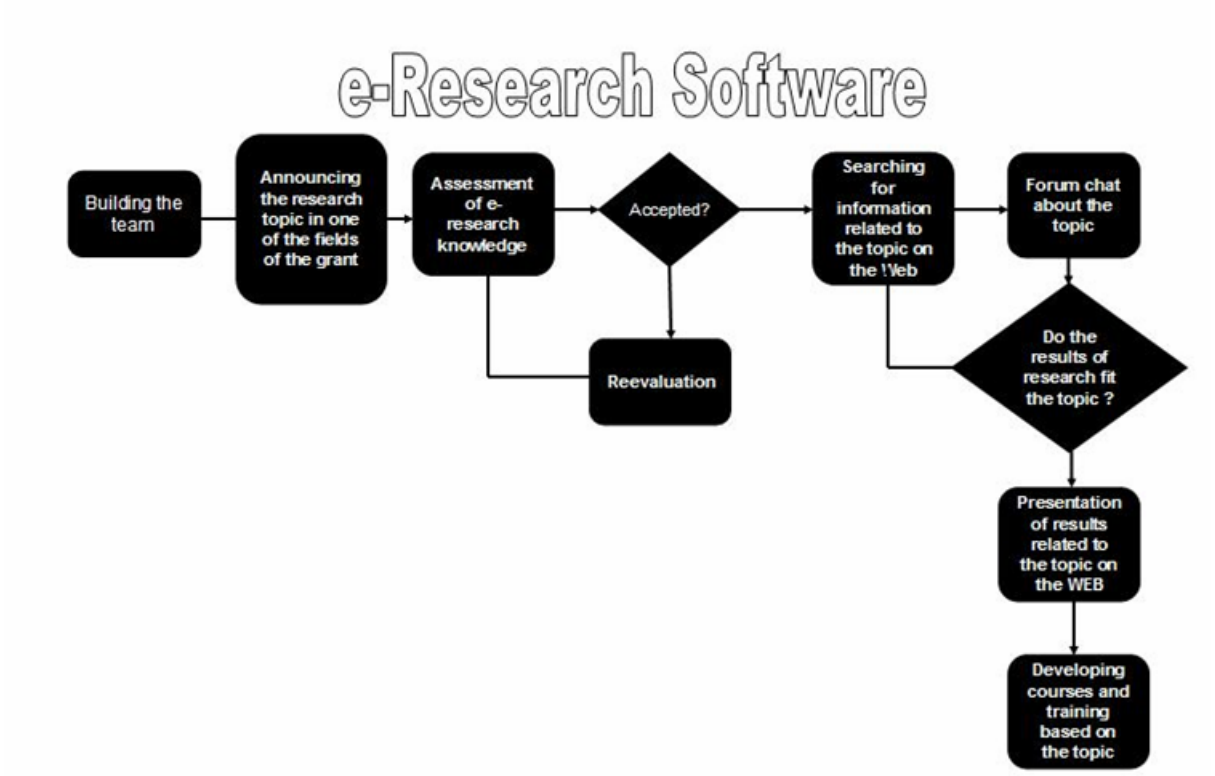

Figure 2 The e-research software

5. CONCLUSIONS

The topic of the e-research centre is meant to develop working procedures and support that would allow research in the mentioned fields using the Internet. In order to accomplish this it is necessary to follow certain steps, through which part of the previously mentioned limitations can be surmounted.

The working algorithm for building the center requires several steps:

- development of the necessary e-research support so as to be seen by the people who are involved in research There may be two situations in this case: working with students who need more information and working with specialists in which case an updating of constructive solutions or research is needed;
- implementing and testing this support on the Internet For this process the center will develop two main departments namely the Steering Department and the Managerial Department. The Steering Department will be responsible for the setting up and functioning of the center; it will have an essential role in establishing the development strategy of the center. The Managerial Department will be responsible for supervising the setting up and functioning of the center made up of a steering committee that will decide on the budget and will ensure liaison with the academic and technical groups in the faculty and outside it. The center will be made up of the following departments: The Leadership of the Center; Department of academic assistance; Department of technical assistance; Department of member support of the e-research center; Department of coordination of the researchers teams; Department of development and coordination of infrastructure; Department of education and training.
- creating portals and chat forums for researchers;
- creating databases for memorizing the research results;
- developing software programs for research related to the mentioned fields;
- developing software programs for education and training in the mentioned fields.
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