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RESEARCH VIRTUAL TEAMS' ESTABLISHMENT AND DEVELOPMENT. THE CASE OF INPRO VIRTUAL RESEARCH NETWORK

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Abstract: Market globalization has instituted an environment of uncertainty and continuous change for all organizations. They have been forced to implement rapid, dynamic, flexible structures and agile teams or groups, known as virtual teams. The paper presents important issues for establishment a virtual team: the importance of elevating goals, virtual team structure, member's competencies, commitment and trust, the collaborative climate, standards of excellence and leadership. After these aspects analysis, we present the case of building the Romanian virtual research network for Integrated Product and Process Engineering - INPRO.

1. INTRODUCTION

"Virtual teams are groups of geographically and/or temporally dispersed individuals brought together via information and telecommunication technologies" [15, p. 365]. Virtual teams are increasingly becoming a key feature of projects in modern organizations, while the landscape of communication tools continues to change dramatically. The benefits of virtualization include diversity of perspectives, large member selection pool, extended hours of productivity, and reduced transportation costs. However, many new challenges arise, such as difficulty in performance monitoring, disappearance of social cues, member isolation and anonymity, and technology issues. In addition, virtual teams must deal with cultural, temporal, and geographic barriers.

In this paper we proposed to analyze the main aspect for establish and develop a high performant virtual team and then to discuss the case of the Romanian Research Network for Integrated Product and Process Engineering (INPRO) building. Finally, some important conclusions are made regarding the efficient way of establishing virtual networks in research.

2. IMPORTANT ISSUES FOR ESTABLISHING A HIGH-PERFORMING VIRTUAL TEAM

2.1. The Importance of Elevating Goal

Larson and LaFasto [9] stress the importance of a clear and elevating goal in the performance of an effective team. They define goal clarity as "a specific performance objective, phrased in such concrete language that it is possible to tell, unequivocally, whether or not that performance objective has been attained" (p. 28) and elevating as "personally or collectively" challenging and that it "makes a difference" (p. 31). While Larson and LaFasto consider this to be the most important component of an effectively functioning team, it appears to be even more critical for a virtual team. Also, Kirkman and Rosen [7] quote a team member from Sabre, Inc. as saying "virtual teams need to understand much more so than co-located teams what goal they are working towards because you are working in such different areas, and in our case, in different countries. It plays a much stronger role if you know what your ultimate target is going to be. Everyone is working towards the same thing." Further work on the performance of virtual teams by Kirkman and Rosen [7], demonstrates a positive correlation between empowerment and

virtual team performance. They define empowerment as having four dimensions, two of which, potency and impact significantly overlap the concepts of goal clarity and elevation.

Virtual team managers should make sure to have a clear and elevating goal for the group and should make sure to prominently display the team mission statement on the virtual work space, team web-site, and other electronic communications to the group.

2.2. Virtual Team Structure

Team structure is a key factor which differentiates successful teams from unsuccessful ones. Team structure encompasses many aspects such as tools, processes, communications systems, facilities, and organization of the team. However, the best structure depends on the objectives and composition of the team.

Virtual teams tend to be very effective in project development tasks. However, the lack of face-to-face contact can be a challenge in building consensus. For decision-making teams, having the right team composition can help to overcome this. Collectivistic teams have higher levels of collaborative conflict management than individualistic teams, and are motivated more by outcomes which benefit the entire team. Research has also shown that highly diverse or heterogeneous teams outperform homogenous teams in many performance measures, though they take longer to reach consensus. Virtuality can be beneficial for highly diverse teams since it obfuscates potentially divisive demographic differences [8].

Larson and LaFasto outlined *four necessary features* of effective team structure, which apply equally to virtual teams, but become more challenging:

1. Team members must have clear roles and accountabilities. Lack of visibility may cause virtual team members to feel less accountable for results, therefore explicit facilitation of teamwork takes on heightened importance for virtual teams. Temporal coordination mechanisms such as scheduling deadlines and coordinating the pace of effort are recommended to increase vigilance and accountability [11].

2. Teams require effective communications systems. This is especially important for virtual teams because geographic and temporal differences may rule out the most common communication channels. “Many in our study found e-mail a poor way for teams as a whole to collaborate” [10]. Individual email conversations cause others to feel left out, but copying everyone causes email overload. Sharing documents over email often leads to conflicting versions. Many successful teams prefer to use virtual work spaces, online forums, instant messaging, and file repositories. Regardless of the communication system, team norms and rewards structures should support use of the systems.

3. Effective teams should monitor individual performance and provide feedback. Assessment and development of virtual team members is very limited in the virtual environment. Performance management is an enormous challenge when employees are out of sight. Managers should monitor group communication to assess subjective factors such as idea generation, leadership, and problem-solving skills [8]. Utilizing peer and customer feedback helps assess contributions to team effectiveness. Managers should also consider using "richer" communication media (such as video conferencing) to more effectively deliver evaluation feedback.

4. Teams must rely on fact-based decision making, for which information and communication tools are vital. Teams can adapt decision-making software to facilitate fact-based problem solving and decision-making [8]. They might also assign one person to ensure accurate information is clearly communicated [15]. Rocketdyne, for example, used collaborative technology to manage knowledge. They allowed all communications to be

recorded and all information to be visible to the team, and even prohibited face to face discussions.

2.3. Members' Competences. Commitment and Trust

Important references [9] recognize three common features of competent team members: technical skills and abilities, desire to contribute, and capability of collaborating effectively. Virtual teams amplify the importance of using appropriate criteria when selecting people for the team.

A critical element in high-performance teams is creating functional diversity among team members, while productively managing resulting task conflict. Work group studies suggest that "such conflict evidently fosters a deeper understanding of task issues and an exchange of information that facilitates problem solving, decision making, and the generation of ideas" [14], p. 22. A best-practice study of successful virtual teams concludes that diversity among disciplines, working styles, and problem-solving approaches can be exploited to produce "solutions instead of acrimony" [10], p.133. Conflict researchers have found that task conflicts can improve team performance if managed collaboratively [17].

However, regardless of other qualifications, not everyone can handle the social isolation of a virtual team. Maintaining this challenging environment requires selection of team members with interpersonal skills, self-regulatory skills, a high level of knowledge, and comfort with technology [4]. This critical balance between technical and interpersonal skills must include the ability to work with others to identify, address, and resolve issues.

Managers should consider using behavioral interviewing techniques and simulations to select team members with unique areas of competence that will contribute to a high-quality solution. Ideally some members should have team process backgrounds. Managers should also provide potential team members with a realistic assessment of virtual team challenges, and the choice to opt out.

Larson and LaFasto [9] suggest that lack of unified commitment is often the most important feature of ineffective teams. They identify two key elements: dedication to the endeavor (commitment) and dedication to the team (unity).

High-performance teams are distinguished by passionate dedication to goals, identification and emotional bonding among team members, and a balance between unity and respect for individual differences. Virtual teams face the challenge of developing and sustaining unified commitment in the absence of face-to-face contact. In particular, they must identify and deal with the most serious threat, competition between individual and team goals.

Kerber and Buono [6] recommend appointing a strong team leader, willing to maintain frequent contact with team members, take full advantage of collaborative technologies, demonstrate a high level of personal commitment, and deal quickly with self-serving and non-contributing team members. Larson and LaFasto suggest that commitment can be enhanced by involving team members in project planning and in defining team identity, goals, and processes. Virtual team leaders should identify commonalities among members early on, while focusing the team on achieving key performance objectives and providing a clear context for recognizing team success.

2.4. Building a Collaborative Climate

"Collaboration flourishes in a climate of trust" [9, p. 87]. Trust is based on social characteristics (familiarity, competence), immediate outcomes of interaction processes

(reliability, integrity), and institutions (social norms, policies). Studies have shown that while trust has little impact on task performance, it can significantly reduce process losses [5].

Trust affects how we interpret member behavior. “Trust is the lens through which these factors are interpreted” [5, p. 253]. Therefore trust plays an important role in virtual teams where ambiguity is high. Unfortunately, building trust is an enormous challenge for virtual teams. “In virtual organizations, trust requires constant face-to-face interaction—the very activity the virtual form eliminates” [8]. Structured opportunities for socialization are less satisfying in virtual environments, and slow development of relational ties.

When a team is formed, expectations about workloads, processes, and contributions lead to “psychological contracts” which can damage trust when broken [15]. Reneging and incongruence are heightened for virtual teams due to the limited ability to communicate.

Studies show that in high-trust teams, structured behavior control mechanisms (rules, progress reports, explicit assignments) intensify the negative effects of reneging and incongruence because they increase salience of member behavior [15]. However, in low-trust teams strong structures actually mitigate the negative effects of trust by minimizing the role trust plays in interpreting member behavior.

Trust is not always dependent on social bonds. Instead, it can be founded on performance consistency. Task-based trust (vs. interpersonal trust) may be more achievable for virtual teams, and can be built by developing norms around communication patterns, ensuring reliable and rapid responses, and making team interaction timely and consistent. [8].

2.5. Standards of Excellence and External Support

Virtual teams are held to the same standards of excellence as conventional teams, but there are subtle differences. Virtual team members often function as the point of contact for their immediate physical group. They often have more autonomy than conventional team members as their teams may meet according to varying time zones which may not be understood by their local management. The presence of a true “invisible team” [9], p. 109 is also a unique component of a virtual team. The “invisible team” is the management team to which each of the members report. The invisible team sets the standards for each member. Misunderstandings may arise if the “invisible team” does not align itself to the same set of expectations. A virtual team leader must understand the level and kind of support from each contributor. Standards of excellence and external support intersect on many levels. Time and energy is well spent at the outset of a virtual team to evaluate the level of excellence the team will achieve. This is especially true when financial contributions require resources outside of the control of the virtual team. Managers of virtual teams need to understand the feasibility of their requests given the context of their members’ management [3].

2.6. Leadership

Principled Leadership is the final ingredient identified by [9] for effective team performance. Pauleen [13] tells us “leadership challenges are magnified in a virtual environment” and stresses the necessity of face-to-face meetings, stating “it is essential for them (leaders) to build personal relationships with team members before commencing a virtual working relationship. Strong relational links are associated with trust, creativity, motivation, morale, good decisions, and fewer process losses.

However, Majchrzak, et al. [10] argues that you can lead high-performing virtual teams without face-to-face meetings and provides several examples of successful teams whose members never met in person. This requires intensive communications to build a coherent identity and hold the team together, and their research found that the leaders of successful virtual teams "rarely let a day go by when members did not communicate with one another" and "frequent phone conversations between the team leader and individual members …were not unusual." Research by Kirkman and Rosen [7] on the performance of virtual teams may provide a clue for leaders attempting to resolve this dilemma. They suggest that periodic face-to-face be held to focus on process improvement, but if this is not feasible "managers need to make extra efforts to empower virtual teams to deal directly and decisively with process improvement issues" [3, p. 188].

Gibson and Cohen [4] suggest virtual team leaders need to engage the group in openly discussing cultural differences and similarities to help develop communication norms. Thompson's work [16] suggests the leader of a virtual team must also play a key role in assessing and balancing team performance levels across the four dimensions: team productivity; team satisfaction; individual growth; and organizational gains. Pauleen [13] states that the leader of a virtual team must: assess team issues, boundaries, organizational policies, resources, and technology; target relationship levels necessary for performance; and develop effective strategies and select and utilize appropriate communication channels.

3. THE CASE OF INPRO RESEARCH NETWORK IN ROMANIA

3.1. Brief overview of the context establishment of INPRO

The **INPRO** – **Romanian Research Network for Integrated Product and Process Engineering** was developed in the context of the **CEEX** national program in 2006. The project joint 121 members (73 PhD, 37 PhD. students, 9 researchers and 2 master students) from 9 research centers, localized in the Universities of Timişoara, Bucureşti, Iaşi, Braşov, Bacău, Suceava, Sibiu and Oradea and a research national institute. They have decided to share their competencies and knowledge in the field of integrated engineering. The project proposal is based on the idea of linking the Romanian scientific research to the European research using the bridge created by the participation of **Politehnica University of Timisoara** (the leader of the proposed project), by the **Integrated Engineering Research Centre** (CNCSIS certificate no.103/2001) in the **Network of Excellence** (NoE) **Virtual Research Lab for a Knowledge Community in Production** (VRL-KCiP), financed by the **6th Framework Program** (FP6) of the European Commission, **contract no. NMP2-CT-2004-507487**. In NoE VRL-KCiP, the partners have the mission to create and develop **national research networks**, to sustain their integration process in the European network, for the development of the **European Research Area**. This objective was attended by setting up the national research network in the field of Integrated Engineering (INPRO). Also, it derive from the need of reducing research fragmentation in the field, for building of a common material and human base that assure the possibility for complex researches in modeling and simulation of product and manufacturing, and processes associated with their life cycle. It will be create a dynamic structure and a collaborative platform in integrated design that will allows its members to participate in collective design projects with industrial applications. The share information process needs the information change into knowledge. Their variety is from the determination of the product specification to the life cycle end, including the processes and the manufacturing systems design. The integration process inside the network will be the

base for the communication system development between the partners and for the knowledge community establishment. The proposed project answer the requests of the FP7 European Commission program for building a **Europe based on the knowledge society principles** [3].

3.2. The INPRO Objectives

The complex project INPRO attend strategic objectives in high scientific-technical (S/T) development through: critical mass concentration (at national level) of human resources and materials (equipment) of high value, in the field of integrated engineering of products and processes in Romania and link them at the European Research Areas (ERA) priorities, objectives and specific activities. The human and material resources allocation in the S/T thematic fields of the project proposal are proved by the partners' competencies and their research results.

The General Strategic Objectives [2] – The project sustains research and development activities that include fundamental, applicative researches of pre-competitive level and which are made together by the INPRO network's partners. This following: integration, increasing quality and performance activities; development of a long time partnership between the partners and regional research centers establishment: South Pole (Bucharest), East Pole (Iaşi-Suceava-Bacău), Central Pole (Braşov-Sibiu), and West Pole (Timişoara-Oradea). The regional research centers will concentrate the scientific research and the human and material resources of high performance from their region, by taking into account their local specific/conditions but, also, for their adapting and integration at the national level. At the regional centers there will be installed visioconferences systems that allowed communication and knowledge share in an operative manner.

The project proposal aims to associate some representative research teams in the field of integrated engineering from the universities: Timişoara, Bucureşti, Iaşi, Bacău, Suceava, Braşov, Sibiu and Oradea and a national research institute, in a consortium of specialists which have decided to share their competencies and knowledge. This consortium will become a representative research centre of excellence for a new research model and for a new system for resources using. It will contribute to the knowledge development as requested by the national strategy for the scientific research development (established by the CEEX) and by the European strategy for ERA creation. The necessity of the INPRO network establishment is a solution for reducing fragmentation in the field of research and for building a joint research base. That will facilitate complex research development in product and processes modeling and simulation by the joint effort of the partners. This is the creation context of a dynamic structure and a collaborative integrated design platform that allowed the members to participate at the joint research projects.

The Specific Strategic Objectives followed by the creation of the INPRO network are:

- Setting up a manufacturing knowledge base in the field of product and processes integrated engineering;
- Increasing research activities performance, stimulating the specialized research team foundation in the priority R&D fields and facilitating the access to the EU research programs;
- Enhancing of the human resources education process by including the young PhD. students in the joint research activities and by assure the access to the disseminating activities in the INPRO network and the connection with VRL-KCiP European;

- Facilitating the mobilities inside the INPRO network and the European network VRL-KCiP;
- Superior valorization of the existing material research base and research cost reduction by creating the possibility to common use of the partners' extant infrastructure;
- Managerial skills development in the scientific research field and increasing the capacity for new financial resources identification.

Considering the holistic approach, the research activities have to be developed by combining fundamental research with the applicative one. The capacity of solving design and production problems, supporting the industrial dynamic processes will determine the consolidation of the INPRO network position and it becomes the best partner for industry. Progressive creation of a common knowledge base and of the reliable structure of the network will allowed us to increase the implication in industrial partnerships which will assure network viability and will strength its' scientific prestige. Small and medium enterprises (SME) will be more and more interested in the collaboration with the research networks. INPRO wish to be implicating in the technology transfer, knowledge dissemination and research results evaluation.

The INPRO project brings an contribution to attend the strategic objective at a high level of S/T knowledge development considering **3 conjugated objectives**: I. Creation, consolidation and development of the INPRO network; II. Initiation and development of jointly executed research activities; III. Spreading of excellence.

3.3. Important Issues for Establishing INPRO Virtual Research Network

Following the aspects presented bellow we shall highlight the key aspects of building the INPRO network as a virtual research organization in Romania.

1. The INPRO ***goals*** were defined clearly in the initial project proposal and then in the contract collaboration between the contractual authority (AMCSIT Politehnica Bucharest) and the coordinator (Politehnica University of Timisoara). The main goals and objectives were presented in the 3.2 paragraph.

The main problem of the organization's members, after one year of the project, is to understand clear the goals and objectives and their perception. Because of this perception process there are:

- Partners that have easy adapt their self into the INPRO and their individual goals are convergent in a great measure with the INPRO goals. This partners are usually main actors in the research activities, too;
- Partners that can not define their goals in the INPRO spirit and they are still trying to understand the changing in doing research by using the virtual environment.

Based on these extreme situations, the Directory Board has to develop new methods and tools for increase the degree of partners' integration in the network. The specific way of working will be based on adequate motivation techniques and new strategic options development.

2. The INPRO ***structure*** was more projects oriented then task oriented in the first year of financed (2006). The organizational structure will change in 2007 in a task oriented one because of the development of the joint program of research activities. These new conditions request the formation of specialized research groups that can work together for attending realistic and effective tasks. But this new organization structure can be implementing by using appropriate group management techniques [3].

Goals and structure are implementing with the support of the organization communication system development. This consists of three parts:

a) *Strengthening of the communication network and tools* that facilitate the collaborative work in the virtual environment. The acquisitions that will be made in the second year of the project (2007) are: visioconference equipment, server and software for the management of knowledge save and knowledge sharing, common knowledge databases. These will support the learning process in the organization, too;
b) *Definitions of tools for external communication support* the activities for the spreading of excellence from the network to the external environment. The created external communication tools are: web site (that include information about the network, the activities developed, results, link to partners, news, e-journal and a section for the monthly report for the researchers work), books and papers made in common, CD that contain demonstrations (case studies, software using etc. – [18]), workshops organization and whole work organization;
c) *Demonstration of software tools and, where possible, making them available to other partners through the Internet.* The software available at the partners are made available to all INPRO members through Internet.

3. The ***members' competencies*** of the INPRO virtual organization were collected using a questionnaire and they define the first form of INPRO's ontology. There were defined 6 categories of concepts that determine the first level of the ontology: Design, Production, Assembling, Using, Disassembling, End-of-life [12]. The ontology was build based on the product life-cycle phases and is used for the future development of the research platform and for the task oriented groups forming.
4. The ***collaborative environment*** was developed based on a model consist four key activities that comprise the research/design and learning process model interact and provide a framework for analysis of successful collaboration based on shared goals, shared understandings, and a common ground of knowledge in INPRO virtual network. The components of INPRO's research/design and learning model, presented in figure 1, include:
    a) *Authentic task* - identifying and taking ownership of a task whose cognitive challenges are consistent with the cognitive demands of the research/design environment for which we are preparing ourselves and our team members;
    b) *Knowledge development* - building a relevant, common base of knowledge, shared experiences and understandings, and associated skills;
    c) *Research* - formulating questions concerning the research/design process and group dynamics that emerge as a result of working on our task;
    d) *Reflection* - consciously reflecting, monitoring, and making explicit our own cognitive orientations and processes in relationship to the group goal.

The distributive, collaborative environment supports knowledge construction and sharing of ideas while enabling individual members to continue work in their own teams or projects. We also found, that the use of computer-mediated communication and our shared space on the Web servers evolved from tools for simply transferring information and building an on-line research reports to a full-fledged learning environment. This enabled INPRO network to construct and share knowledge, to take individual ownership of specific sections of finished research reports and the resources used to create them, to engage in an ongoing dialogue, and to reflect upon our individual and group activities [1].

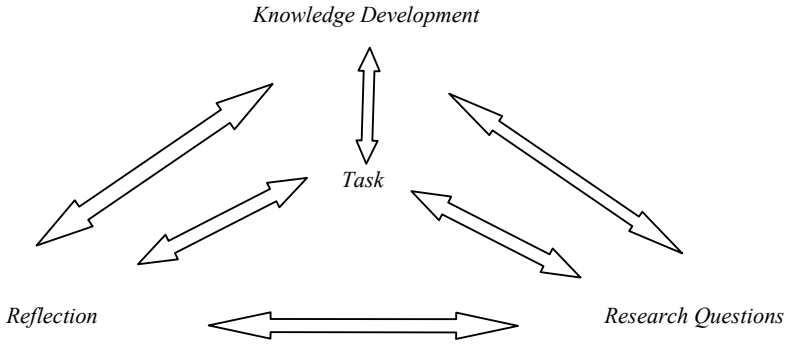

Figure 1. A Model of the Collaborative Design Environment

5. ***Standards of excellence*** are continuous survived by the Directory Committee by the evaluation of the research work results. They are in consensus with the AMCSIT evaluation indexes.
6. ***Leadership*** – A disparate group self-organizes into an interdependent community of learners, with common discourse based on shared expertise, strategies, values, and representational tools. Leaders of the teams involved in the INPRO virtual organization began to share leadership and discourse activities, which are normally reserved for a manager or leader (task leader or work package leader), while the manager became a full participant in the research (design) process. At various times, different members of the group took the lead in helping the team manages time and resources. This shared leadership contributed to group coherence in INPRO virtual organization [1].

4. CONCLUSIONS

Virtual teams must deal with problems that befall face-to-face teams, along with some unique challenges. At the same time, they have the potential to realize additional process gains and deliver high-quality solutions by bringing together diverse individuals with complementary knowledge without the limitations of physical, organizational or cultural boundaries. The competitive environment places a premium on the quality and speed of solutions, and technology is providing increasingly richer collaboration tools – advancing from the telephone and the fax machine to video conferencing and virtual workspaces in a little over a decade. Organizations that learn to harness the power of virtual teams with these collaborative technologies will gain significant competitive advantage [1].

Theoretical aspects have been supported by an example of best practice in the case of the Romanian virtual research network INPRO. Based on representative references, we have provided comprehensive state-of-the-art documentation about building a virtual team. INPRO network is a good example of building a performant virtual organization. The process of established such an organization in research strongly depends on the development of the collaborative environment.

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