

## Concurrent Collaboration in Research and Development

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*Abstract – Integration is the essence of current research and development (R&D) activity in many organizations. Integration can be established in various ways depending on the type, size and intricacy in organizational functions and products. Nevertheless, research and development (R&D) has become an inevitable function in most manufacturing companies in order to develop their own product niches for their survival in the prevailing highly competitive market environment. Research and development functions are fundamental drivers of value creation in technology-based enterprises. Of creating and maintaining a vibrant R&D environment, organizations individually or collectively need to incorporate virtual R&D team. A virtual R&D team can introduce new product in less lead time than by conventional R&D working. Therefore, how to increase the possibility of having more successful R&D is a critical issue for enterprises. This paper examines the current approach of collaboration in R&D issues from the perspective of their impact on virtual R&D team in enterprises and compares the findings with the other concepts of concurrent collaboration. By reviewing literature and theories, the paper firstly presents the definition and characteristics of virtual R&D teams. A comparison of different types of virtual R&D teams along with the strengths and limitations of the preceding studies in this area are also presented. It is observed that most of the research activities encourage and support virtual R&D teams applicable to enterprises. Distinctive benefits of establishing virtual R&D team have been enumerated and demand future attention has been indicated in the paper.*

**Keywords – Research and Development; Virtual team; Concurrent Collaboration;**

### I. INTRODUCTION

International collaboration in research and development (R&D) is becoming increasingly important in creating the knowledge that makes research and business more competitive. Organizations are currently facing critical and unprecedented challenges in an ever dynamic, constantly changing and complex business environment [1]. All types of economic activities are moving in the direction of globalization [2]. From the other direction, the growing internationalization of R&D activities challenges multinational corporations (MNCs) to formulate technology strategies and manage increasingly diffused and assorted networks of R&D laboratories and alliances in the context of disparate national institutions [3]. By the emergence of the increasing de-centralization and globalization of work processes, many organizations have responded to their dynamic environments by introducing virtual teams. Additionally, the rapid development of new communication technologies such as the Internet has accelerated this trend so

that today, many large organizations employ virtual teams to some degree or other [4]. Considering that R&D teams need to access and retrieve information from as many sources as possible [5], virtual teams are important mechanisms for organizations seeking to leverage over scarce resources across geographic and other boundaries. [6].

With the rapid development of electronic information and communication media in the last decades, distributed work has become much easier, faster and more efficient [4]. Now global communication is so much easier, faster and cheaper, therefore managing and integrating geographically dispersed R&D has considerably increased [7]. It's a widely held belief that the modern work-world is dominated by computer-mediated communication, and this communication is the bread and butter of virtual teams [8].

As another milestone phenomenon, over the last few decades, R&D teams have become increasingly virtual [9]. The main advantage of implementing a geographically dispersed R&D network structure is the ability to tap selectively into center of excellence [10]. To shrink the cost and protract the length of total system and product development life cycles, many organizations have moved away from serial to concurrent collaboration through the use of cross-functional, integrated project/product teams [11]. Virtual teams were formed to facilitate transnational innovation processes [12] and it should be noted that innovation has a positive impact on corporate performance [5]. Also a virtual network structure is used to improve communication and coordination, and encourage the mutual sharing of inter-organizational resources and competencies [13]. The growing complexity and competition in the business world are major drivers for increasing the popularity and formation of virtual teams [14].

Concurrent collaboration in research and development has been described in different ways with various implications. One the most important issue is virtual R&D team that is focused in this paper from the point of its useful definition and characteristics, strengths and limitations as well as diversity.

### II. VIRTUAL R&D TEAMS

It is worth mentioning that virtual teams are often formed to overcome geographical or temporal separations [15]. Virtual teams work across boundaries of time and space by utilizing modern computer-driven technologies. The term "virtual team" is used to cover a wide range of activities and forms of technology-supported working [16]. Simple transmission of information from point A to point B is not

enough; the virtual environment presents significant challenges to effective communication [8]. Gassmann and Von Zedtwitz [12] defined “virtual team as a group of people and sub-teams who interact through interdependent tasks guided by common purpose and work across links strengthened by information, communication, and transport technologies.” From the perspective of Leenders et al. [17] virtual teams are groups of individuals collaborating in the execution of a specific project while geographically and often temporally distributed, possibly anywhere within (and beyond) their parent organization. Amongst the different definitions of the concept of a virtual team the following from is one of the most widely accepted: Powell et al. [18], “we define virtual teams as groups of geographically, organizationally and/or time dispersed workers brought together by information technologies to accomplish one or more organization tasks ”

### III. DIFFERENT TYPES OF VIRTUAL R&D TEAMS

Generally, we can differentiate various forms of “virtual” work depending on the number of persons involved and the degree of interaction between them. The first is “telework” (telecommuting) which is done partially or completely outside of the main company workplace with the aid of information and telecommunication services. “Virtual groups” exist when several teleworkers are combined and each member reports to the same manager. In contrast, a “virtual team” exists when the members of a virtual group interact with each other in order to accomplish common goals. Finally, “virtual communities” are larger entities of distributed work in which members participate via the Internet, guided by common purposes, roles and norms. In contrast to virtual teams, virtual communities are not implemented within an organizational structure but are usually initiated by some of their members. Examples of virtual communities are Open Source software projects [4]. Computer mediated collaborations (CMC) is also used to encompass asynchronous interactions through a collaborative workspace, as well as e-mail, instant messaging, and synchronous interactions using a system that incorporates desktop videoconferencing, shared workspace, chat and other features [19]. Extended enterprise concept in parallel with the concurrent enterprising looks for how to add value to the product by incorporating to it knowledge and expertise coming from all participants on the product value chain [20].

Teleworking is viewed as an alternative way to organize work that involves the complete or partial use of ICT to enable workers to get access to their labor activities from different and remote locations [21]. One of the basic ideas of concurrent engineering needed for product design and development is to assemble a team that is focused on developing or redesigning a product [11]. Concurrent engineering is a conceptual methodology that enables all who are impacted by the product design to have early access to design information and have the ability to influence the final

design to identify and prevent future problems and it is different from virtual team working.

Cascio and Shurygailo [15] have clarified the difference between by classifying virtual teams with respect to two primary variables namely, the number of location (one or more) and the number of managers (one or more) Table 1 illustrates this graphically. Therefore there are four categories of teams:

- Teleworkers: A single manager of a team at one location
- Remote team: A single manager of a team distributed across multiple location
- Matrixed teleworkers: Multiple manager of a team at one location
- Matrixed remote teams: Multiple managers across multiple locations

Table 1: Forms of Virtual Teams (source: Cascio and Shurygailo, 2003)

		Managers	
		One	Multiple
Locations	One	Teleworkers	Matrixed Teleworkers
	Multiple	Remote Team	Matrixed Remote Teams

The statistics show that teleworking is more frequent among information-intensive activities like software development. But it is not so frequent among other activities in new product development [21].

### IV. DIVERSE CONCERN OF VIRTUAL TEAMS

As a drawback, virtual teams are particularly vulnerable to mistrust, communication break downs, conflicts, and power struggles [22]. On the other hand, virtual teams reduce time-to-market [23]. Lead Time or Time to market has been generally admitted to be one of the most important keys for success in manufacturing companies [20]. Table 2 summarizes some of the main advantages and disadvantages associated with virtual teaming [24]. Anderson et al. [16] suggest that the effective use of communication, especially during the early stages of the team’s development, plays an equally important role in gaining and maintaining trust.

Virtual teams are useful for projects that require cross-functional or cross boundary skilled inputs and the key to their value creation is to have a defined strategy in place to overcome the issues highlighted, especially the time zones and cultural issues. While communication could be seen as a traditional team issue, the problem is magnified by distance, cultural diversity and language or accent difficulties. For migration or similar large-scale projects, personal project management competency, appropriate use of technology and networking ability, willingness for self-management, cultural and interpersonal awareness is fundamentals of a successful

virtual team [25]. Virtual team may allow people to collaborate more productivity at a distance, but the tripe to coffee corner or across the hallway to a trusted colleague is still the most reliable and effective way to review and revise a new idea [26]. Face-to-face collaboration (FFC) appears to be better suited for relatively unstructured discussion, intensive tasks, such as developing a conceptual understanding of a problem or evaluating key ideas and negotiating how to proceed, in contrast those tasks that lend themselves to a structured approach are most effectively accomplished during computer-mediated collaboration (CMC) [19]. A potential advantage of virtual teams is their ability to digitally or electronically unite experts in highly specialized fields working at great distances from each other [22].

Table 2: some of the main advantages and disadvantages associated with virtual teaming (source: Bergiel et al., 2008).

Advantages	Disadvantages
Reduces travel time and cost	Sometimes requires complex technological applications
Enables the recruitment of talented employees	Lack of knowledge among employees about virtual teams and subsequent, there is the need for HRD (Human Resource Development) interventions
Promotes different areas	Lack of knowledge among some senior mature managers concerning advanced technological applications
Builds diverse teams	Not an option for every type of employee because of an employee's psychological make-up and other predispositions
Assists in promoting proactive employment practices for disadvantaged individuals and groups	Nor an option for every company because of the operational environment
Reduces discrimination	

Virtual teams are significantly different from traditional teams. In the proverbial traditional team, the members work next to one another, while in virtual teams they work in different locations. In traditional teams the coordination of tasks is straightforward and performed by the members of the team together; in virtual teams, in contrast, tasks must be much more highly structured. Also, virtual teams rely on electronic communication, as opposed to face-to-face communication in traditional teams. Table3 summarizes these distinctions [27].

Table3: Virtual and traditional R&D teams are usually viewed as opposites.

Fully Traditional Team	Fully Virtual Team
Team members all co-located.	Team members all in different locations.
Team members communicate face-to-face (i.e., synchronous and personal)	Team members communicate through asynchronous and apersonal means.
Team members coordinate team task together, in mutual adjustment.	The team task is so highly structured that coordination by team members is rarely necessary.

In particular, reliance on computer-mediated communication makes virtual teams unique from traditional ones [6].

The joint work is intended to attain the following beneficial objectives [28].

- to minimize the number of parts and operations;
- to ensure that process capabilities are known, and that the design either falls within these parameters or that there is enough time to improve and acquire new capabilities as needed;
- to use standard procedures, materials, and processes of already known and proven quality;
- to design multifunctional and multi-use components and modules;
- to design for ease of joining, separating, and rejoining;
- to design for one-way assembly;
- to avoid delicate designs requiring extraordinary effort or attentiveness .

Yip and Dempster [29] in their study realized that Perhaps the most important lesson is that the Internet helps companies to be both global and local at the same time. It is possible to derive the virtual teams substitute with internet. The internet can facilitate the collaboration of different people who are involved in product development, increase the speed and the quality of new product testing and validation and improve the effectiveness and the efficiency of product development and launch [21]. Rice et al. [19] found that the adoption of formal procedures and structured processes significantly increased the effectiveness of virtual teams. Arranz and Arroyabe [30] point out that geographical dimension is not a variable that impacts substantially on the typology and objectives of R&D cooperation, in contrast with the results highlighted in the literature review that they have done. Virtual teams have more effective R&D continuation decisions than face-to-face teams because virtual team has asynchronous communication and it allows for more time for digestion and reduces the pressure of group conformity [31]. Distributed teams can carry out critical tasks with appropriate decision support technologies [14].

## V. CONCLUDING REMARKS

In the rapidly changing environment on which the emergence of new technologically complex products is being witnessed every day gaining the knowhow and the right knowledge for keeping pace with the rate and intensity of change has become an inevitable necessity. There has been increasing pressure on enterprises to enhance their chances of survival in the turbulent and changing environments. Virtual teams bring about knowledge spillovers within enterprises bridging time and place; therefore the decision on setting up virtual teams is not a choice but a requirement. The globalization of and the new waves of global trends in economy, services and business along with advances in telecommunications technology have paved the way for the formation and the performance of virtual teams.

The literature so far has not paid adequate attention to the virtual R&D team activities in enterprises. While reviewing the preceding studies, it's believed that the advantages of working on the basis of virtual teams far outweigh the disadvantages.

The industrial consultants should aim to teach their customer/managers not only new management techniques but also the skill of applying the virtual team concept in R&D. The government should encourage local firms to build up their virtual R&D team with the relevant enterprises. The benefit of establishing virtual R&D team has been made quite apparent by this paper and demand future attention.

## VI. REFERENCES

- [1] Rezgui, Y., *Exploring virtual team-working effectiveness in the construction sector*. Interacting with Computers, 2007. **19**: p. 96–112.
- [2] Acs, Z.J. and L. Preston, *Small and Medium-Sized Enterprises, Technology, and Globalization: Introduction to a Special Issue on Small and Medium-Sized Enterprises in the Global Economy*. Small Business Economics, 1997. **9**: p. 1-6.
- [3] Li, J. and D.R. Yue, *Managing Global Research and Development in China: Patterns of R&D Configuration and Evolution*. Technology Analysis & Strategic Management, 2005. **17**(3): p. 317–337.
- [4] Hertel, G.T., S. Geister, and U. Konradt, *Managing virtual teams: A review of current empirical research*. Human Resource Management Review, 2005. **15**: p. 69–95.
- [5] Kafourous, M.I., et al., *The role of internationalization in explaining innovation performance*. Technovation, 2008. **28**: p. 63–74.
- [6] Munkvold, B.E. and I. Zigurs, *Process and technology challenges in swift-starting virtual teams*. Information & Management, 2007. **44**: p. 287–299.
- [7] Hegde, D. and D. Hicks, *The maturation of global corporate R&D: Evidence from the activity of U.S. foreign subsidiaries*. Research Policy, 2008. **37**: p. 90–406.
- [8] Walvoord, A.A.G., et al., *Empowering followers in virtual teams: Guiding principles from theory and practice*, *Computers in Human Behavior (article in press)*. 2008.
- [9] Kratzer, J., R.T.A.J. Leenders, and J.M.L.V. Engelen, *Managing creative team performance in virtual environments: an empirical study in 44 R&D teams*. Technovation, 2006. **26**: p. 42–49.
- [10] Criscuolo, P., *On the road again: Researcher mobility inside the R&D network*. Research Policy, 2005. **34**: p. 1350–1365
- [11] Bochenek, G. and J. Ragusa, *Improving Integrated Project Team Interaction Through Virtual (3D) Collaboration*. Engineering Management Journal, 2004. **16**(2): p. 3.
- [12] Gassmann, O. and M. Von Zedtwitz, *Trends and determinants of managing virtual R&D teams*. R&D Management 2003. **33**(3): p. 243-262.
- [13] Chen, H.H., et al., *Developing new products with knowledge management methods and process development management in a network*. Computers in Industry, 2008b. **59**: p. 242–253.
- [14] Chen, M., et al., *Team Spirit: Design, implementation, and evaluation of a Web-based group decision support system*. Decision Support Systems, 2007. **43**: p. 1186–1202.
- [15] Cascio, W.F. and S. Shurygailo, *E-Leadership and Virtual Teams*. Organizational Dynamics, 2003. **31**(4): p. 362-376.
- [16] Anderson, A.H., et al., *Virtual team meetings: An analysis of communication and context*. Computers in Human Behavior, 2007. **23**: p. 2558–2580.
- [17] Leenders, R.T.A.J., J.M.L.V. Engelen, and J. Kratzer, *Virtuality, communication, and new product team creativity: a social network perspective*. Journal of Engineering and Technology Management, 2003. **20**: p. 69–92.
- [18] Powell, A., G. Piccoli, and B. Ives, *Virtual teams: a review of current literature and directions for future research*. The Data base for Advances in Information Systems, 2004. **35**(1): p. 6–36.
- [19] Rice, D.J., et al., *Improving the Effectiveness of Virtual Teams by Adapting Team Processes*. Computer Supported Cooperative Work, 2007. **16**: p. 567–594.
- [20] Sorli, M., et al., *Managing product/process knowledge in the concurrent/simultaneous enterprise environment*. Robotics and Computer-Integrated Manufacturing, 2006. **22**: p. 399–408.
- [21] Sanchez, A.M., M.P. Perez, and P.D.L. Carnicer, *Teleworking and new product development*. European Journal of Innovation Management, 2006. **9**(2): p. 202-214.
- [22] Rosen, B., S. Furst, and R. Blackburn, *Overcoming Barriers to Knowledge Sharing in Virtual Teams*. Organizational Dynamics, 2007. **36**(3): p. 259–273.
- [23] May, A. and C. Carter, *A case study of virtual team working in the European automotive industry*. International Journal of Industrial Ergonomics, 2001. **27**: p. 171-186.
- [24] Bergiel, J.B., E.B. Bergiel, and P.W. Balsmeier, *Nature of virtual teams: a summary of their advantages and disadvantages*. Management Research News, 2008. **31**(2): p. 99-110.
- [25] Lee-Kelley, L. and T. Sankey, *Global virtual teams for value creation and project success: A case study*. International Journal of Project Management 2008. **26**: p. 51–62.
- [26] Gassmann, O. and M. Von Zedtwitz, *Innovation Processes in Transnational Corporations*. International Handbook of Innovation, ed. L.V. Shavinina. 2003: Elsevier Science Ltd.
- [27] Kratzer, J., R. Leenders, and J.V. Engelen, *Keeping Virtual R&D Teams Creative*. Industrial Research Institute, Inc., 2005. **March-April**: p. 13-16.
- [28] Naveh, E., *The effect of integrated product development on efficiency and innovation*. International Journal of Production Research, 2005. **43**(13): p. 2789–2808.
- [29] Yip, G. and A. Dempster, *Using the Internet to Enhance Global Strategy*. European Management Journal, 2005. **23**(1): p. 1–13.
- [30] Arranz, N. and J.C.F.D. Arroyabe, *The choice of partners in R&D cooperation: An empirical analysis of Spanish firms*. Technovation, 2008. **28**: p. 88–100.
- [31] Cummings, J.L. and B.S. Teng, *Transferring R&D knowledge: the key factors affecting knowledge transfer success*. Journal of Engineering Technology Management, 2003(20): p. 39–68.