

Virtual R&D team: Technology Transfer Facilitator

Nader Ale Ebrahim¹, Mohammad Ali Shafia², Hamid Tahbaz Tavakoli³

¹*Department of Engineering Design and Manufacture,
Faculty of Engineering, University of Malaya
50603 Kuala Lumpur, Malaysia
E-mail: aleebrahim@perdana.um.edu.my*

²*Professor, Faculty of Industrial Engineering,
Iran University of Science and Technology,
E-mail: omidshafia@iust.ac.ir*

³*Managing Director, the R&D Society of Iranian Industries and Mines
E-mail: Iranrd@Iranrd.org*

Abstract:

A conceptual model is proposed which facilitate the process of technology transfer by applying a virtual R&D team. The underlying hypothesis is responded to competitive challenges, the complex customer requirements and the high instability on the market. The context of the knowledge-based economy introduces a major shift from serial to simultaneous R&D activities in the way technology transfer is conceived. The traditional model of R&D team work is relies on the visual and face-to-face teams. The complexities involved in organizing face-to-face interactions among team members from one side, and the rapid developments of electronic communication technologies from the other ,caused firms to turn towards employing virtual R&D teams. The paper postulates that in the new perspective, virtual R&D team to be considered as a specific technology transfer means. It depends on the ways firms and other institutions are managing them, in particular the co-evolution of their absorptive capabilities and their technology conveying strategies. To support the theoretical analysis, this paper provides a comprehensive review based on authentic and reputed publications.

Keywords: *Virtual R&D team; Technology Transfer; Conceptual model*

Introduction:

To meet the technological requirements of industry & boost entity international competitiveness, companies should rely on operations of a virtual R&D technology transfer network. These requirements are fundamentally linked to the flow of information, assignment of competency, and transfer of authority in international R&D organization. It is central for international technology and knowledge transfer between dispersed R&D sites[1]. Major trends like globalization and high demand fluctuation force companies and supply chains to innovate

new business models to gain and maintain competitive position. Networking, outsourcing, and information and communication technology are considered as general tools and means to respond to these challenges [2]. Consequently, multinational companies (MNCs) have increased their investment on research and development abroad [3]. While the outsourcing activities of the MNCs was highly concentrated in a handful of economies by the beginning of the global R&D stream, the offshore outsourced R&D activities have now been more geographically dispersed and this indeed reveals the increasing value of networking affairs. These multiple sites encourage the development of more ideas, due to the varied international backgrounds in global networks [4].

Virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographical and other boundaries. Besides, virtual collaboration has become vital to most organizations. This is particularly true in the context of designing new product and service innovation. Such collaboration often involves a network of partners located around the world. However at the R&D project level, dealing with such distributed teams, challenges both managers and specialists. Virtual teams reduce time-to-market of newly developed products and based on some evidence collaboration amongst geographically distributed engineers at manufacturer and supplier sites, yielding some mutual benefits in terms of better quality, reduced costs and a reduction of the time-to-market between 20 to 50 percent for a new product [5]. The decision to use a virtual team is often a necessity rather than a choice; being 'virtual' is in most cases not a strategy but an operational reality [6]. Despite numerous studies on the topic in recent years, there still appears the need to a vision what a virtual R&D team is, and how it can impact technology transfer process.

In this paper the following aspects are thoroughly looked at in technical terms: comprehensive definition of virtual R&D teams, the impact of virtual R&D teams on technology transfer process, trends in organizing virtual R&D teams, benefit and pitfall of virtual team's application, R&D collaboration in distributed environment, and web base collaborative system. Details of pertinent practical guidelines and implications for R&D managers are also derived.

Definition of Virtual R&D teams

It worth mentioning that, virtual teams are often formed to overcome geographical or temporal separations [7]. Virtual teams work across time and space boundaries by utilizing modern computer-driven technologies. The term "virtual team" is used to cover a wide range of activities and forms of technology-supported affairs [8]. Virtual teams are comprised of members who are located in more than one physical location. This team trait has fostered extensive use of a variety of forms of computer-mediated communication that enable geographically dispersed members to coordinate their individual efforts and inputs [9]. Gassmann and Von Zedtwitz [6] defined "virtual team as a group of people and sub-teams who interact through interdependent tasks guided by common purpose and work across links backed by information, communication,

and transport technologies.” Another definition suggests that virtual teams are distributed work teams, whose members are geographically dispersed and coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, telephone, etc.) [10]. Different authors have identified diverse areas. From the perspective of Leenders et al. [11] 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 organizations. Lurey and Raisinghani [12] defined virtual teams as groups of people who work together although they are often dispersed across space, time, and/or organizational boundaries. Amongst the different definitions of a virtual team the following concept from which the term depicted in this paper, is one of the most widely accepted definition: [13], “virtual teams are as groups of geographically, organizationally and/or time dispersed workers brought together by information technologies to accomplish one or more organization tasks ”

Virtual R&D team and its role in technology transfer processes

In order to ensure future sustainability, large amount of money is spent all over the world on R&D [14]. However, research is an investment, not an expense. Investment in commercial R&D usually involves a high-risk with a deferred payoff. Return can also be tremendously attractive [15]. From different point of views the increasing complexity and inter-disciplinary nature of the R&D process in turn has increased the cost of research. Therefore, research become less attractive without partners to share the cost [16]. The success of R&D initiative is generally conditional on the stipulation of soft technology and the interdisciplinary character of the R&D itself [17]. Technological change is a highly dynamic process that may quickly relocate to take advantage of optimum conditions for growth [18]. In a virtual R&D group, contributing information may substitute for more traditional methods of establishing credibility, usually found in co-located groups [19]. The use of virtual teams, especially in international R&D projects, seems well established and is likely to continue [6]. For most R&D teams, being virtual is a matter of degree [11]. May and Carter [5] in their case study of virtual team working in the European automotive industry have shown that enhanced communication and collaboration between geographically distributed engineers at automotive manufacturers and suppliers sites make them acquiring benefits in terms of quality, reduced costs and a reduction in the time-to-market (between 20% to 50%) for a new product.

R&D is a strategy for developing technologies that can be commercialized under independent intellectual property rights. R&D enables firms to create new technologies and/or to build on existing technologies obtained through technology transfer [17]. Technology transfer is a way to increase the efficiency in the innovation system. It gives a profitable utilization of the research and development[20]. Virtual R&D team improve communication and coordination, and encourage the mutual sharing of inter-organizational resources and competencies [21]. It is also

provide organizations with unprecedented level of flexibility and responsiveness [13, 22-28]. Virtual technology transfer that would save costs, generate value and increase flexibility of the company. Entity must leverage the adoption process with virtual R&D to maximize the speed and ease of technology transfer from its partners.

Trends in organizing virtual R&D teams

Based on interviews with 204 R&D directors and project managers in 37 technology-intensive multinational companies, Gassmann and Von Zedtwitz [6] have concluded five trends in organizing virtual R&D teams, which are :

1. Continued internationalization of R&D will further increase the importance of and reliance on virtual R&D teams.
2. Virtual R&D teams will better integrate talent in newly industrialized countries.
3. Advances in information and communication technologies will further enhance the functionality of virtual teams.
4. Relative costs of running virtual R&D projects will decrease due to learning curve effects.
5. Highly decentralized virtual R&D teams will gain importance in open system architectures such as internet-based applications.

In next section some benefaction and drawback of applying virtual teams will be described.

Benefit out of applying virtual teams

Virtual teams reduce time-to-market [5, 23-25, 29-36]. Lead time or time to market has been generally admitted to be one of the most important keys for success in manufacturing companies [29]. Time also has an almost 1:1 correlation with cost, so cost will likewise be reduced if the time-to market is quicker [37]. Virtual teams overcome the limitations of time, space, and organizational affiliation that traditional teams face [27] and reducing relocation time and costs, reduced travel costs [25, 28, 30, 38-45]. One of the most important of employ virtual R&D team is able to tap selectively into center of excellence, using the best talent regardless of location [25, 41, 42, 44, 46-50].

Virtual team also, respond quickly to changing business environments [34, 40], generate the greatest competitive advantage from limited resources [39, 51, 52], greater degree of freedom to individuals involved with the development project [25, 49, 53], higher degree of cohesion [41, 54, 55], cultivating and managing creativity [11, 25, 49, 56], sharing knowledge, experiences; Facilitate knowledge capture [36, 48, 57-59], greater productivity, shorter development times[34, 38], more effective R&D continuation decisions [60, 61], most effective in making decisions [62, 63], better team outcomes[27, 55, 64], higher team effectiveness and efficiency[5, 65] and reduce training expenses, Faster Learning [49, 56, 66].

Pitfall of virtual teams application

Virtual team encountered vulnerable to mistrust, communication break downs, conflicts, and power struggles [41, 57, 67-69]. Sometimes requires complex technological applications[40, 49]. Cultural and functional diversity in virtual teams lead to differences in the members' thought processes. Develop trust among the members are challenging [30, 49, 50, 70-76]. It is worth mentioning that virtual team have a challenges of; managing conflict[27, 77-79], determining the appropriate task technology fit [49, 70, 71, 78, 80], project management[49, 73, 81] and will create challenges and obstacles like technophobia (employees who are uncomfortable with computer and other telecommunications technologies) [82].

Anderson et al.[8] 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 often face tight schedules and a need to start quickly and perform instantly [76]. 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 [83]. Face-to-Face collaboration (FFC) appears to be better developing a conceptual understanding of a problem [30, 39, 41, 62]. In a virtual team environment, collaborative and competitive conflicting behavior is positively linked with performance [13], depending on the degree of virtuality [64] and team connectivity [64]. As drawbacks, virtual teams are particularly vulnerable to mistrust, communication break downs, conflicts, and power struggles [57].

Conceptual Model

Based on the virtual R&D definitions and its advantage and disadvantage, the following conceptual model is proposed. The one is shown in Figure 1 (adapted and modified from [84], illustrates the interrelationships between virtual R&D team, work, and technology within the broader context of organizational, social, and technical environments. Selecting an appropriate technical tool or integrating advanced technologies to support the task of virtual team and evaluation requires that all model elements be considered individually and collectively and that all interrelationships are understood. For example, in modern organizations technology directly links the social to the technical environments, as virtual R&D team serve as the bridge between technical and organizational environments. As a result, teams using new technology can have an effect and be affected by all three environments.

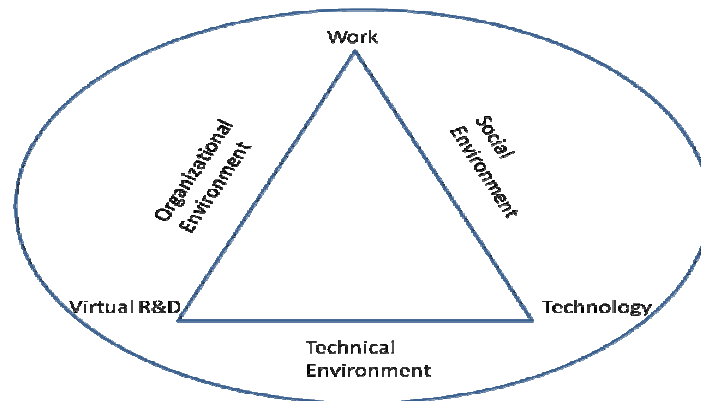


Figure 1 a proposed conceptual model

R&D collaboration in distributed environment

Firms need to collaborate with internal and external parties in order to enhance the success of their new products [85]. Networked R&D management emphasizes both internal and external collaboration. Internal coordination and collaboration are still major challenges, and cross-functional in-company collaboration must be enhanced e.g. by setting up cross-functional teams, external R&D networks include collaboration and integration with complementary corporations between suppliers and customers and research centers [86].

Grinmaldi and Tunzelmann [87] classified the benefits of R&D collaboration from companies point of view and extracted the following benefits:

- Economies of scale and scope in research;
- Reducing product or process costs;
- Acceleration of R&D;
- Avoidance of unnecessary duplication of research;
- Risk management;
- Financial support for costly projects or equipment;
- Technology and knowledge transfer, assimilation and utilization;
- Hiring university students or graduates;
- Enhancement of reputation.

External-technology integration plays an important role in many operational activities [88]. New ideas and insights do not occur in isolation; they are the result of collaboration. Indeed, the innovation era ultimately unfolds knowledge, which is its key asset. Collaboration may render meta-capability by which knowledge will be exploited to drive innovation and reap its economic benefits [89]. The use of collaborative technology that requires users to categorize the comments they received from others result in increased information processing, which in turn lead to better decisions and more satisfied participants [90]. In high-risk areas, R&D collaboration can be used

as an optional strategy for risk sharing, where small stakes in risky projects enable further investments and it is a major motivators for R&D collaboration [86]. Narula [91] by analyzing European technology firms found that both large and small firms have similar motives to undertake inter-firm R&D collaboration. The primary motivation for both groups of firms was not considered to be the reduction of risks or costs, but the reduction of innovation time span, and the access to complementary technologies.

Web Base Collaboration

The internet, incorporating computers and multimedia, has provided tremendous potential for remote integration and collaboration in business and manufacturing applications [92]. But it is still hard to allocate funding and to design infrastructures and software to support virtual team working [93]. Despite computers' widespread use for personal applications, very few programming frameworks exist for creating synchronous collaborative applications [94]. A web-based collaborative product design platform enables authorized users in geographically dispersed locations to have access to the company's product data such as product drawing files stored at designated servers and carry out product design work simultaneously and collaboratively in any operating systems [95].

Conclusion

The globalization 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. Despite the enormous benefaction of virtual R&D team and virtual publicity, the application of virtual team to technology transfer and enhance business operation by most enterprises, is still at its infancy. While reviewing the previous study, it is believed that the advantages of working on the basis of virtual teams far outweigh the disadvantages. Virtual teams bring about knowledge spillovers within enterprises bridging time and place, reduce time-to-market, reduced travel costs, ability to tap selectively into center of excellence, using the best talent regardless of location, greater degree of freedom to individuals, shorter development times, provide flexible hours for the employees the working hours, creates and disperses improved business processes across organizations, provide organizations with unprecedented level of flexibility and responsiveness, reduce resistance to change, reduce the pollution, Optimize the contributions of individual members toward the completion of business tasks and organizational goal, facilitate transnational innovation processes, respond quickly to changing business environments, employees can be assigned to multiple, concurrent teams and finally higher team effectiveness and efficiency. Therefore the decision on setting up virtual teams is not a choice but a requirement. Global market requires short product development times.

Technology transfer management requires a careful definition of virtual R&D team and its effect to reduce time-to-market and capacities of increase the firm core competence. Dealing with virtual R&D team can bring new findings. This study suffers from limitation of coverage almost all publication. In spite of this limitation, the survey suggests that there are still substantial gaps in virtual R&D team effects on technology transfer.

References

1. von Zedtwitz, M., O. Gassmann, and R. Boutellier, *Organizing global R&D: challenges and dilemmas*. Journal of International Management, 2004. **10**: p. 21-49.
2. Salmela, E. and A. Lukka, *Value added logistics in supply and demand chains SMILE. Part 1 : Ebusiness between global company and its local SME supplier network*, Research Report 153, ISBN 951-764-925-8. 2004. p. 76.
3. Reger, G., *Coordinating globally dispersed research centers of excellence—the case of Philips Electronics*. Journal of International Management, 2004. **10**: p. 51– 76.
4. Richtne'r, A. and J. Rognes, *Organizing R&D in a global environment-Increasing dispersed co-operation versus continuous centralization*. European Journal of Innovation Management, 2008. **11**(1): p. 125-141.
5. 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.
6. Gassmann, O. and M. Von Zedtwitz, *Trends and determinants of managing virtual R&D teams*. R&D Management 2003. **33**(3): p. 243-262.
7. Cascio, W.F. and S. Shurygailo, *E-Leadership and Virtual Teams*. Organizational Dynamics, 2003. **31**(4): p. 362-376.
8. Anderson, A.H., et al., *Virtual team meetings: An analysis of communication and context*. Computers in Human Behavior, 2007. **23**: p. 2558–2580.
9. Peters, L.M. and C.C. Manz, *Identifying antecedents of virtual team collaboration*. Team Performance Management,, 2007. **13**(3/4): p. 117-129.
10. 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.
11. 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.
12. Lurey, J.S. and M.S. Raisinghani, *An empirical study of best practices in virtual teams* Information & Management, 2001. **38**(8): p. 523-544.
13. 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.
14. Precup, L., et al., *Virtual team environment for collaborative research projects*. International Journal of Innovation and Learning, 2006. **3**(1): p. 77 - 94
15. Boer, F.P., *Research is an investment, not an expense*. Applied Catalysis A: General, 2005. **280**: p. 3–15.
16. Howells, J., A. James, and K. Malik, *The sourcing of technological knowledge: distributed innovation processes and dynamic change*. R&D Management, 2003. **33**(4): p. 395-409.
17. Zhouying, J., *Globalization, technological competitiveness and the 'catch-up' challenge for developing countries: some lessons of experience*. International Journal of Technology Management and Sustainable Development 2005. **4**(1): p. 35-46
18. 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.
19. Ahuja, M.K., D.F. Galletta, and K.M. Carley, *Individual Centrality and Performance in Virtual R&D Groups: An Empirical Study* Management Science, 2003. **49**(1): p. 21-38.
20. Axelsson, J.v., *Transfer of production knowledge to small and medium-size enterprises - a suggested model*, in *Department of Production Engineering*. 2005, Royal Institute of Technology: STOCKHOLM. p. 118.
21. Chen, H.H., et al., *Developing new products with knowledge management methods and process development management in a network*. Computers in Industry, 2008. **59**: p. 242–253.
22. Hunsaker, P.L. and J.S. Hunsaker, *Virtual teams: a leader's guide*. Team Performance Management, 2008. **14**(1/2): p. 86-101.

23. Chen, T.-Y., *Knowledge sharing in virtual enterprises via an ontology-based access control approach*. Computers in Industry, 2008. **Article In press**: p. No of Pages 18.
24. Guniš, A., J. Šišlák, and Š. Valčuha, *Implementation Of Collaboration Model Within SME's*, in *Digital Enterprise Technology-Perspectives and Future Challenges*, P.F. Cunha and P.G. Maropoulos, Editors. 2007, Springer US. p. 377-384
25. Prasad, K. and K.B. Akhilesh, *Global virtual teams: what impacts their design and performance?* Team Performance Management, 2002 **8**(5/6): p. 102 - 112.
26. Pihkala, T., E. Varamaki, and J. Vesalainen, *Virtual organization and the SMEs: a review and model development*. Entrepreneurship & Regional Development, 1999 **11**(4): p. 335 - 349.
27. Piccoli, G., A. Powell, and B. Ives, *Virtual teams: team control structure, work processes, and team effectiveness*. Information Technology & People, 2004. **17**(4): p. 359 - 379.
28. Liu, B. and S. Liu, *Value Chain Coordination with Contracts for Virtual R&D Alliance Towards Service*, in *The 3rd IEEE International Conference on Wireless Communications, Networking and Mobile Computing, WiCom 2007*. 2007, IEEE Xplore: Shanghai, China. p. 3367-3370.
29. Sorli, M., et al., *Managing product/process knowledge in the concurrent/simultaneous enterprise environment*. Robotics and Computer-Integrated Manufacturing, 2006. **22**: p. 399-408.
30. Kankanhalli, A., B.C.Y. Tan, and K.-K. Wei, *Conflict and Performance in Global Virtual Teams*. Journal of Management Information Systems, 2006. **23**(3): p. 237-274.
31. Shachaf, P., *Cultural diversity and information and communication technology impacts on global virtual teams: An exploratory study*. Information & Management, 2008 **45**(2): p. 131-142.
32. Kusar, J., et al., *How to reduce new product development time*. Robotics and Computer-Integrated Manufacturing 2004. **20**: p. 1-15.
33. Ge, Z. and Q. Hu, *Collaboration in R&D activities: Firm-specific decisions*. European Journal of Operational Research 2008. **185**: p. 864-883.
34. Mulebeke, J.A.W. and L. Zheng, *Incorporating integrated product development with technology road mapping for dynamism and innovation*. International Journal of Product Development 2006 **3**(1): p. 56 - 76.
35. Zhang, S., W. Shen, and H. Ghenniwa, *A review of Internet-based product information sharing and visualization*. Computers in Industry 2004. **54**(1): p. 1-15.
36. Sridhar, V., et al., *Analyzing Factors that Affect Performance of Global Virtual Teams*, in *Second International Conference on Management of Globally Distributed Work 2007*: Indian Institute of Management Bangalore, India. p. 159-169.
37. Rabelo, L. and T.H.S. Jr., *Sustaining growth in the modern enterprise: A case study*. Journal of Engineering and Technology Management JET-M, 2005. **22**: p. 274-290.
38. McDonough, E.F., K.B. Kahn, and G. Barczak, *An investigation of the use of global, virtual, and collocated new product development teams*. The Journal of Product Innovation Management, 2001. **18**(2): p. 110-120.
39. Rice, D.J., et al., *Improving the Effectiveness of Virtual Teams by Adapting Team Processes*. Computer Supported Cooperative Work, 2007. **16**: p. 567-594.
40. 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.
41. Cascio, W.F., *Managing a virtual workplace*. The Academy of Management Executive, 2000. **14**(3): p. 81-90.
42. Fuller, M.A., A.M. HARDIN, and R.M. DAVISON, *Efficacy in Technology-Mediated Distributed Team* Journal of Management Information Systems, 2006. **23**(3): p. 209-235.
43. Olson-Buchanan, J.B., et al., *Utilizing virtual teams in a management principles course*. Education + Training, 2007. **49**(5): p. 408-423.
44. Boudreau, M.-C., et al., *Going Global: Using Information Technology to Advance the Competitiveness Of the Virtual Transnational Organization*. Academy of Management Executive, 1998. **12**(4): p. 120-128.
45. Biuk-Aghai, R.P., *Patterns of Virtual Collaboration*, in *Faculty of Information Technology*. 2003, University of Technology: Sydney. p. 291.
46. Criscuolo, P., *On the road again: Researcher mobility inside the R&D network*. Research Policy, 2005. **34**: p. 1350-1365
47. Samarah, I., S. Paul, and S. Tadisina. *Collaboration Technology Support for Knowledge Conversion in Virtual Teams: A Theoretical Perspective*. in *40th Hawaii International Conference on System Sciences (HICSS)*. 2007. Hawaii.

48. Furst, S.A., et al., *Managing the life cycle of virtual teams*. Academy of Management Executive, 2004. **18**(2): p. 6-20.
49. Badrinarayanan, V. and D.B. Arnett, *Effective virtual new product development teams: an integrated framework*. Journal of Business & Industrial Marketing, 2008. **23**(4): p. 242-248.
50. Boutellier, R., et al., *Management of dispersed product development teams: The role of information technologies*. R&D Management, 1998. **28**(13-25).
51. Martins, L.L., L.L. Gilson, and M.T. Maynard, *Virtual teams: What do we know and where do we go from here?* Journal of Management, 2004. **30**(6): p. 805-835.
52. Chen, T.Y., Y.M. Chen, and H.C. Ch, *Developing a trust evaluation method between co-workers in virtual project team for enabling resource sharing and collaboration*. Computers in Industry 2008. **59**(6): p. 565-579.
53. Ojasalo, J., *Management of innovation networks: a case study of different approaches*. European Journal of Innovation Management, 2008. **11**(1): p. 51-86.
54. Kratzer, J., R. Leenders, and J.V. Engelen, *Keeping Virtual R&D Teams Creative*. Industrial Research Institute, Inc., 2005. **March-April**: p. 13-16.
55. Gaudes, A., et al., *A Framework for Constructing Effective Virtual Teams* The Journal of E-working 2007 **1**(2): p. 83-97
56. Atuahene-Gima, K., *The effects of centrifugal and centripetal forces on product development speed and quality: how does problem solving matter?* . Academy of Management Journal, 2003. **46**(3): p. 359-373.
57. Rosen, B., S. Furst, and R. Blackburn, *Overcoming Barriers to Knowledge Sharing in Virtual Teams*. Organizational Dynamics, 2007. **36**(3): p. 259-273.
58. Zakaria, N., A. Amelinckx, and D. Wilemon, *Working Together Apart? Building a Knowledge-Sharing Culture for Global Virtual Teams*. Creativity and Innovation Management, 2004. **13**(1): p. 15-29.
59. Merali, Y. and J. Davies, *Knowledge Capture and Utilization in Virtual Communities*, in *International Conference On Knowledge Capture, K-CAP'01*. 2001: Victoria, British Columbia, Canada. p. 92-99.
60. 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.
61. Schmidt, J.B., M.M. Montoya-Weiss, and A.P. Massey, *New product development decision-making effectiveness: Comparing individuals, face-to-face teams, and virtual teams*. Decision Sciences, 2001. **32**(4): p. 1-26.
62. Hossain, L. and R.T. Wigand, *ICT Enabled Virtual Collaboration through Trust*. Journal of Computer-Mediated Communication, 2004. **10**(1).
63. Paul, S., et al., *Impact of heterogeneity and collaborative conflict management style on the performance of ynsynchronous global virtual teams*. Information & Management, 2004. **41**(3): p. 303-321.
64. Ortiz de Guinea, A., J. Webster, and S. Staples. *A Meta-Analysis of the Virtual Teams Literature*. in *Symposium on High Performance Professional Teams Industrial Relations Centre*. 2005. School of Policy Studies, Queen's University, Kingston, Canada.
65. Shachaf, P. and N. Hara, *Team Effectiveness in Virtual Environments: An Ecological Approach*, in *Teaching and Learning with Virtual Teams*, P.a.G. Ferris, S., Editor. 2005, Idea Group Publishing. p. 83-108.
66. Pena-Mora, F., et al., *CAIRO: a concurrent engineering meeting environment for virtual design teams*. Artificial Intelligence in Engineering 2000. **14**: p. 203-219.
67. Kirkman, B.L., et al., *Five challenges to virtual team success: lessons from Sabre Inc*. Academy of Management Executive, 2002. **16**(3): p. 67-79.
68. Taifi, N., *Organizational Collaborative Model of Small and Medium Enterprises in the Extended Enterprise Era: Lessons to Learn from a Large Automotive Company and its dealers' Network.*, in *Proceedings of the 2nd PROLEARN Doctoral Consortium on Technology Enhanced Learning, in the 2nd European Conference on Technology Enhanced Learning*. 2007, CEUR Workshop Proceedings.: Crete, Greece.
69. Baskerville, R. and J. Nandhakumar, *Activating and Perpetuating Virtual Teams: Now That We're Mobile, Where Do We Go?* IEEE Transactions on Professional Communication, 2007. **50**(1): p. 17 - 34
70. Bell, B.S. and S.W.J. Kozlowski, *A Typology of Virtual Teams: Implications for Effective Leadership*. Group and Organization Management, 2002. **27**(1): p. 14-49.
71. Griffith, T.L., J.E. Sawyer, and M.A. Neale, *Virtualness and Knowledge in Teams: Managing the Love Triangle in Organizations, Individuals, and Information Technology*. MIS Quarterly, 2003. **27**(2): p. 265-287.