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RUSSIAN HIGH-SPEED SOFTWARE DEVELOPMENT

Overcoming the Challenges of Globalization

Jan Pries-Heje[1], Richard Baskerville[2], and Galina Ianshina Hansen[1]
[1]*The IT University of Copenhagen, Denmark;* [2]*Georgia State University USA*

Abstract: High-speed software development uses a number of techniques to move software quickly into production. Examples of these techniques include prototyping for fast requirement definition, release-oriented project management for scope control, and parallel development for rapid product completion and quality control. These techniques are spreading rapidly among software developers worldwide. Using the Kline model of innovation diffusion and the Greiner model of evolution and growth of organizations we analyze the enablers and barriers to diffusion of high-speed software development techniques in Russia. This analysis reveals a complex interaction of political, economic and technical elements that both enable and inhibit the development of knowledge necessary to support this case of innovation diffusion.

Keywords: Software Engineering, Information Systems Development, Agile Systems Development, Diffusion of Innovation.

1 INTRODUCTION

Since the commercialization of the Internet and the explosion of applications that followed the invention of the World Wide Web and browser technology researchers have studied this area intensively. One of the most interesting observations has been that there seems to have developed a practice of developing and launching software applications at high speed. In a study in U.S. of companies that believe they work at Internet speed (Ramesh et al., 2002) revealed a number of so-called Internet Speed practices. In the concrete the following nine High-Speed – or Internet Speed – practices were identified:

1. Parallel Development

2. Release Orientation
3. Tool Dependence
4. Customer Involvement
5. Prototyping
6. Fixed Architecture
7. Components
8. Maintenance Ignored
9. Tailored Methodology

The differences included the use of parallel development processes to speed up development. A new breed of tools that automated much of the development has emerged. Customers are being intensely involved in development, guiding the acquisition and prioritization of requirement chunks. Prototyping is being heavily used in understanding requirements as well as in developing throwaway and iterative releases. The critical role of good architectural design is well recognized. Developers are forced to reuse components as much as possible. Development has to take place in chunks of functionality, and an extreme release orientation is used to accommodate the need for speed and fixed delivery schedules. Maintenance issues often are ignored. The development process and methodology are tailored to match the needs for quality and speed for the next release. Further, they are also constantly changing and evolving as the products, markets and software development organizations mature.

These techniques are spreading rapidly among software developers worldwide. These are featured in popular new methodologies such as eXtreme Programming. The techniques are also visible in studies of both large and small organizations developing software for Internet applications (Baskerville et al., 2001). The benefits of these techniques, or at least the claimed benefits, are well known and this information alone provides a strong motive and credible explanation for *why* this rapid diffusion is occurring.

What is missing is an explanation of *how* these techniques are spreading in a borderless fashion. Our research was initiated by our curiosity towards whether Internet Speed practices had gone completely global, or were contained within developed consumer economies? In other words: Would we find the same practices in countries with emerging consumer economies? We were presented with an opportunity to study Internet Speed practices in one of the largest and most important emerging European consumer economies: Russia. This setting makes an ideal subject not only for reasons of size and importance, but also because of well-organized state programs to promote Internet and computing technology.

Internet Speed practices are relatively recent achievements in developed commercial economies. By examining these practices in Russia, we seek to

discover if these techniques are diffusing to developing economies, and if so, how these are diffusing. In analyzing these phenomena, we use the Kline model of innovation diffusion. Analysis using this model enables us to discover the enablers and barriers to diffusion of high-speed software development techniques in Russia.

2 RESEARCH METHOD

We selected Russian software development as an arena of particular interest from the viewpoint of globalization. We can highlight three key reasons for this interest. First, we appreciate the sheer geographical size (12 time zones) and importance of Russia in the world. Second, in opposition to the geographical size, we discovered that the Russian Internet market is tiny when compared to countries in Western Europe or in North America. According to *PulseOnline,* only 1-2 percent of the population of 145 million people accesses the Internet regularly (2001). A third reason is the widely circulated prediction that this small percentage is expected to rise dramatically. Optimistic estimates predict upwards of 50% annual growth. Compared to the relatively low percentage of today's Internet access, Russia is characterized as a "developing country" in the arena of Internet software development with serious prospects of becoming a leading country within a relatively short period.

Having chosen Russia, in mid-October 2002 we conducted a number of interviews with three Russian software houses. Table 1 provides overview profiles of these companies. We also interviewed managers from a Danish software company with ten years of experience in outsourcing software development to a Russian software house in Saint Petersburg. Furthermore we carried out an extensive literature and internet search for documents in both English and Russian related to the issue of high-speed and internet software development in Russia.

Overall our research follows well-established research methods used in qualitative research. We carried out data collection through telephone interviews using a semi-structured interview guide.

3 CASE FINDINGS

We will discuss the case findings in two sections. First, we will describe the nature of software development at high-speed as found empirically in the Russian cases. Second we will describe some of the Russian political initiatives described in the literature.

3.1 High-Speed Software Development

From a general perspective, we found a surprising degree of usage of high-speed software development techniques in Russian. All four of the software developing organizations in our study used some or several (but not all) of the techniques. Less surprisingly, the development of these techniques is not traced to training by universities or technical schools. Given the surprising degree of usage, we more expectedly found that the Internet itself has been the effective mechanism for spreading new knowledge about high-speed software development.

Table 1. Profiles of the Russian companies studied

Name (Pseudo-nym)[1]	**Industry and What offered?**	**When Founded, and Size?**	**Inter-viewed**	**Organizational Roles represented**
InterSoft	Intranet and internet systems, such as on-line catalogue shopping, content management, project planning and control system	Founded in 1999, 10-12 employees	One	Technical Director/ Chief of Maintenance Department
RusERP	Offers bookkeeping systems, ERP systems	Founded in 1991, 15 employees	Two	Two persons have been interviewed - developer and marketing chief
FinSoft	Applications to the Financial Sector	Founded in 1997, 53 employees	Two	Two persons have been interviewed - Analyst and Developer
BridgeOut	Decision support, Planning and scheduling applications for industrial, environmental and civil defense use	Founded in 1992, Subsidiary company (50%) of Danish Software House, 20 employees in Russia, 50 employees in Denmark (working together)	Three	CEO in Danish mother company, manager responsible for Russian development, manager responsible for outsourcing

In the remainder of this section, we provide a more detailed perspective on each case and how the techniques have evolved for these companies. We will also give some specifics about where the development knowledge arises.

[1] All the Russian Software companies requested anonymity.

Intersoft didn't recognize the term "Internet Speed," but was nevertheless in no doubt about the content of the term. They were feeling time pressure in all their projects, whether these were for the Internet, for an intranet, or for some traditional software application. Intersoft was using parallel development heavily as their specific solution to cope with time pressure. They were also using a fixed architecture to save time, at least in some projects. They were tailoring their process – or their method – and this was justified because of the diversity of their customers and projects. Intersoft had looked at things such as eXtreme Programming (Beck, 2000), Rational Unified Process (Kruchten, 2000) and Agile methods (Aoyama, 1998). They had found the latter to be especially interesting and inspiring. However, we didn't find customer involvement to the degree most agile methods recommend. In fact Intersoft said that they didn't like it and only involved customers "if a customer insisted to be involved". We also did not find that their designs ignored maintenance. In fact, we found quite the opposite, since Intersoft members were quite proud of their ability to maintain their software products. Finally, when asked what their source of information and learning about these high-speed techniques had been, the answer was primarily the Internet plus a number of journals.

RusERP are developing both standard (ERP-like) products and totally new Internet-based products. They reported time pressure in producing these products, especially in the newer kind of projects. In response to this time pressure, RusERP now largely uses parallel development. To some extent they were working also with a fixed architecture and were dependent on tools for developing software. They agreed that they were often ignoring maintenance issues in their projects, but usage of this technique was dependent on the customer. The only learning source for new techniques they mentioned was the Internet.

FinSoft reported time pressure when developing the more important modules of a system, but not if it is just a "nice to have" module. Finsoft claims to use a fixed three-layer architecture. They also very often involve customers. Prototyping is a means for customer involvement, very commonly to communicate and get feedback from customers. Furthermore to cope with time pressure (for important modules/systems) parallel development and release orientation are applied. For those purposes, developers at FinSoft are dependent on tools. Again at Finsoft, the Internet was mentioned as a primary source of information and knowledge about high-speed techniques, together with different books, courses, and journals.

BridgeOut told us that "time to market is decisive, … to be first in a market means everything." This goal brings them time pressure. On the other hand, BridgeOut has also experience with launching a new product too early. In this case, "too early" means that, at launch, the product was of such inferior quality that it would forever destroy the product's potential.

BridgeOut had worked especially on tailoring their methodology. This tailoring work had begun since their first prototyping development approach 10-15 years ago. After this initial work, they adopted a waterfall-influenced methodology, which was used to plan, and implement the cooperation between the Danish headquarters and the Russian subsidiary. However, they have since abandoned the waterfall-model and have now replaced it with an iterative methodology. This is an adaptive approach in which the number of iterations and the content of each are determined by those involved in each individual project. "I have so much confidence in iterative methods that I will use them in any situation" says the Manager responsible for Russian development. BridgeOut is also using parallel development in the sense that processes are taking place in Denmark and in Russia at the same time for the same project. In general, BridgeOut has a development process that includes several iterations with frequent deliveries (releases). BridgeOut has also looked at eXtreme Programming (Beck, 2000), trying, for example, Pair Programming. However they found Pair Programming was too stressful for their developers. Finally, BridgeOut is also using courses, journals, new books and the Internet to find new knowledge.

3.2 Russian Software Political Initiatives

The importance and growth of the Internet has not gone unnoticed in Russia. For example, they have launched a very ambitious federal program called "Electronic Russia 2002-2010" in January 2002. The program recognizes information and communication technologies (ICT) "as spurring economic change and development, boosting Russia's international competitiveness, improving the productivity and responsiveness of government, and creating a more educated, informed, and engaged citizenry" (Azrael and Peterson, 2002).

This program is not directly aimed at increasing the efficiency of the economy by developing a Russian high-tech or Internet marketplace. Rather it is aimed at improving management in the public sector, governmental performance, and transparency in decision-making. There are four concrete improvement goals comprising Electronic Russia 2002-2010 (Lakaeva, 2001; 2002; Hiltunen, 2002):

1. A more friendly environment in the form of effective legislation, and better communication between public institutions and private organizations such as the Internet software houses we interviewed
2. An Internet infrastructure in the form of better telecommunication networks, as well as access to electronic libraries, archives and databases. More specifically, every city in Russia with more than 30,000 inhabitants should be connected.

3. E-Government through the establishment of e-commerce market places for state procurement and other commercial activities of the state. Thus in 2010 it is expected that 65% of all internal and up to 40% of external (across state organizations) communication is done in electronic form.
4. E-Education by providing computer training for education professionals and delivering a wide-range of distance learning packages.

Electronic Russia 2002-2010 aimed at creating a friendly environment (the first part of no. 1 above) in 2002, conducting feasibility studies and pilot projects in 2003-2004, and implementing the program at full scale 2005-2010 (Lakaeva, 2001). In general this Russian federal initiative has been received quite positively. For example Kimmo Sasi, the Finnish Minister of Transport and Communication, called it "a timely document that could increase the efficiency of the Russian economy" (Hiltunen, 2002).

However, criticism has also been raised. Azrael and Peterson (2002), for example, question whether resources will be available and state that "it is not clear that focusing on IT should be a priority at this time for Russian government or industry." And Hiltunen (2002) quotes Russian speakers at a conference in Helsinki as saying "that the programme is in many ways detached from what an average Russian person needs and can afford."

4 ANALYSIS

In this section we begin with an analysis of key enablers of the diffusion of these high-speed development techniques. For this purpose we will introduce the Kline (1985) linked-chain model of innovation diffusion. We selected the linked-chain model because the diffusion of high-speed software techniques across economies is undoubtedly knowledge intensive. It is a feature of post-industrial economics that recognizes how information industries have assumed a powerful, ideological role among consumer societies in knowledge economies. Kline's linked-chain model is a knowledge-centric process model that is not linear in nature. Its knowledge-centricity is important for modeling the origins and flow of knowledge related to the techniques. From the perspective of the Kline model, the Russian diffusion of these techniques appears to be well enabled.

After our discussion of the key enablers, we will turn our focus to the barriers confronting this diffusion. For this purpose we will introduce a model of organizational evolution and growth by Larry Greiner (1972; 1998). We selected Greiner's model of the evolution of organizations because it appears that the software houses in the Russian Internet

development market are relatively small organizations. Given the key enablers suggested by an analysis using the Kline model, we can expect these firms to evolve rapidly the coming years. Greiner's model explicates organizational evolution and growth, and suggests the barriers the companies will be facing in this forthcoming evolution. From the perspective of the Greiner model, the Russian diffusion of these techniques faces some challenges. As a consequence, this model will also suggest enablers needed to overcome future barriers to the development of this high-speed software development industry.

4.1 Kline Linked Chain Model

Unlike linear models that define sequential patterns for idealized cases of the innovation process, five concurrent pathways or links characterize the linked chain model. In Figure 1, arrows denote these concurrent links within the other elements of the model. These elements are (1) market finding, an assessment of a product improvement or new product that meets an unfulfilled market; (2) analytical design, which is a preliminary design activity that establishes the scope of further design alternatives; (3) development, which includes detailed design, prototyping, and testing; (4) production, which includes redesign for manufacture and production; (5) marketing, which includes distribution as well as product marketing; (6) research and knowledge, which together constitute pure science. Knowledge is placed between the elements of the innovation chain and research as a buffer to imply that the store of human knowledge may often fuel the innovation chain without further research processes. According to this model, "research leads to product innovation only insofar as it stimulates a design via either invention or analytical design" (Kline, 1985: p.37). The concept of analytical design as distinct from design is not well-explored elsewhere in the literature, but might be characterized as the invention of a design through a complex intellectual trial-and-error process. The design component of development is also innovation, since it is an inductive and creative activity of the mind that synthesizes the old and new to satisfy its goals.

The links or pathways in the innovation chain include (1) central chain, which represents the long pathway of innovation through each element from market finding to marketing; (2) feedback links, which flow dynamically back-and-forth across the central chain boundaries especially product-improvement and new product innovation arising from market discovery process; (3) knowledge-linked research, innovation arising from the interaction of knowledge and the elements of analytic design, development, production and research; (4) invention-linked research, from the

unstructured exploration of analytical designs; (5) product-linked research, regarding long-range product and "support for science" research.

The linked-chain model enables several major innovation diffusion implications important for understanding the Russian high-speed software development situation. First, knowledge is the base of innovation and its diffusion. Research alone is not the direct base of innovation, but is indirectly critical for creating the store of knowledge. Second, the systems and process research associated with product development and production are generally undervalued innovation elements. Third, a preoccupation with science has diminished our recognition of invention and analytic design as key elements of innovation. Fourth, our understanding of creativity and innovation in design is poorly developed, especially in terms of the interaction between the closely related activities of invention and analytic design.

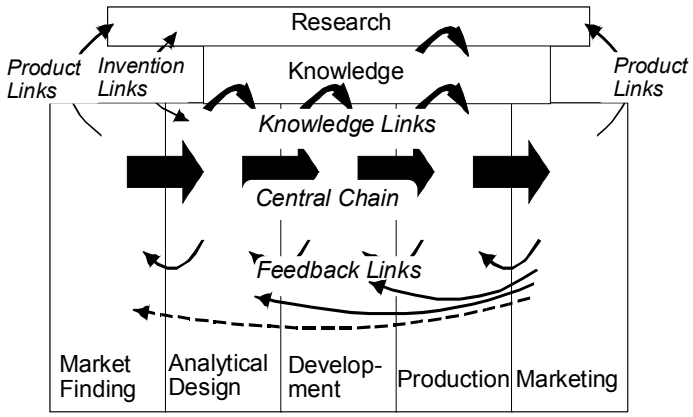

Figure 1. Kline's Linked-Chain Model

4.2 Analysis: Enablers of Diffusion of Practices in Russia

An analysis of the cases indicates four key Enablers of Diffusion that affect the transfer of these Internet Software Practices into and within Russia. These include (1) Internet-based research, (2) rapidly developed knowledge through the Russia 2002-2010 Internet expansion, and (3) the demands of rapidly developing markets through the Russoft Outsource marketing program. A fourth enabler (4) appears to be a developing social

norm that software copyrights for high cost development tools can be disregarded unless they are generating revenue.

The first two key enablers are interlocking. Perhaps foremost is the availability of the Internet for purposes of research. This research, as shown in Figure 1, is important for all five phases of the product innovation cycle and for developing and maintaining the knowledge base required for innovation diffusion. It was thematic in our cases that the major research source for developing knowledge on Internet speed software development is the Internet itself.

> *The importance of the Internet as one important source of learning was thematic. InterSoft learned about Internet Speed development techniques "from different journals and the Internet", FinSoft and BridgeOut from "different books, courses, journals and the Internet", and at RusERP, the only learning source mentioned was - the INTERNET.*

The second of these interlocking enablers is the growing body of knowledge that is proceeding from this research. This knowledge, according to the Kline model (Figure 1), is especially important for design, development, production, and marketing of software products in Russia. Both the research and the knowledge developments would seem to have been enhanced by the Russia 2002-2010 Internet expansion project. A good illustration of this was found in BridgeOut who says:

> *"We have good telephone connections to Saint Petersburg and Moscow. But connections to the remainder of Russia are lousy. As for the Internet there are only 8 hubs for my email to pass from Denmark to Russia, whereas my email from home to my office in Denmark has to pass 12 hubs".*

The third key enabler of the diffusion of Internet Speed techniques is embodied in the efforts to develop a marketplace for Russian software products. The clearest embodiment of this enabler is in the Russoft outsource software marketplace being vigorously developed by Russian software industry groups. This project covers the marketing and market-finding elements in the Kline model.

> *"A number of associations (Rusoft, Inforus) similar in function to the Indian's NASSCOM was formed to promote Russian software development companies in the U.S., Europe, Asia and to improve Russia's image as that of a reliable center for offshore software development". (Luxoft, 2002: p.7).*

A fourth key enabler is especially representative of the knowledge links between research, knowledge, design and the processes of development and production. It regards a potential barrier to these links arising from the high cost and inaccessibility of many of the software development tools such as software development environments, object-oriented design packages, etc. These tools have been shown to be a feature of Internet speed development (Ramesh et al., 2002). Because access to these tools is difficult to acquire at low cost in Russia, some of these tools are being made accessible through back channels. The back channels are in no way planned or accommodated by any real organization, but rather have become enabled by a social network. The social network seems to be Internet enabled, and embodies some of the important knowledge links suggested by the Kline model (see Figure 1). The ability to acquire freely these tool packages enables developers and their organizations to research, experiment and build the minimum necessary knowledge and skills to compete with other Internet Speed software developers. Once the knowledge has been acquired, and serious production yields revenues, the software tools are subsequently acquired through more traditional front channels.

"Intellectual property and security are major concerns of companies considering offshore software development in Russia. Thankfully, the laws on intellectual property ownership in Russia are relatively clear and developed. While enforcement of these laws remain a problem for domestic consumer level products (music, movies, clothing), there have been no recorded violations of intellectual property rights in the offshore software development industry" (Lewin, 2001: p.5).

4.3 Greiner's Model of the Evolution of Organizations

As mentioned in the introduction to this section, the small-sized firm orientation of the Russian high-speed software development industry suggests a forthcoming field of organizational growth, adaptation, and development. A useful model for suggesting future barriers (and necessary future enablers) can be found in Greiner's (1972; 1988) evolutionary model. Figure 2 shows the five phases of organizational development and change as defined by Greiner. An organization starts its life in the "Creativity" phase shown in the lower left corner. In this phase, the founders of the company are typically entrepreneurs, communication among the people in the organization is informal, long work hours are normal, and the feedback from the market is immediate, as well as the reaction from management.

As the company grows in size and matures, it then reaches its first crisis, namely the "leadership crisis". Informal communication is no longer sufficient. The dedication, long hours and small salaries of the first hired "pioneers" are no longer sufficient motivation. Furthermore new procedures

are needed to exploit efficiencies of size and to provide better financial control. To solve the leadership crisis a strong manager is needed. Often the owner/founders don't have the necessary skills and knowledge, and so will "hate to step aside even though they are … unsuited to be managers" (Greiner, 1972; 1998).

When well through the leadership crisis the surviving organization will "embark on a period of sustained growth under able and directive leadership" (Greiner, 1972; 1998). In this second phase, communication becomes more formal, a hierarchy is built within the organization, and the upper levels take responsibility for the direction of the organization. It is also in this phase that formalized systems for accounting, incentives, work practice and job specialization will arise.

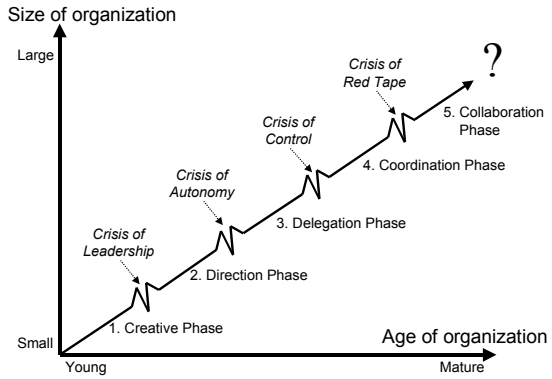

Figure 2. Greiner's model of organizational evolution and revolution

The second crisis then is the "autonomy crisis". Middle-level managers see the centralized decision structure of the second phase organization as a burden, and some of the more autonomous field unit middle managers will start running their own shows. Often the reaction by top management is an attempt to return to centralized management. To solve the second crisis a more decentralized organization structure is needed where middle management has greater responsibility and autonomy.

Phase three ends in the "control crisis" where top management realizes that they have lost "control over a highly diversified field operation." This crisis is overcome by the use of coordination techniques such as formal planning, creation of product groups treated as investment centers, and by initiating staff functions that controls and reviews for line managers.

The next crisis then is the crisis of "red tape" where the line is looking at staff functions with more suspiciousness, and distrustfulness evolves between headquarters and the field. Overcoming this crisis then leads the organization into what Greiner calls "the last observable phase in previous studies." In this last phase strong interpersonal collaborations are established to overcome the red-tape crisis. A more flexible and behavioral approach to management is implemented through the use of teams. The staff functions

are reduced in number. And the motivational structure becomes more geared to team performance than to individual achievements.

4.4 Analysis: Barriers to Diffusion of Practices in Russia

An analysis of our four cases in relation to Greiner's model indicates a number of barriers for the future diffusion of high-speed software development practices in Russia. The model also suggests some potential enablers for overcoming these barriers.

First the prospects for establishing new companies seem quite bright. Thus new companies will enter phase 1 in Greiner's model where growth is primarily spurred by creativity. BridgeOut describes the market for qualified IT people in very positive terms:

> *"In Russia you have access to a pool of very strong resources ... highly motivated and well educated ... i.e. in Saint Petersburg you have about 50 technical schools and universities with more than 200,000 students to choose among ... financially attractive compared to salaries in Denmark. And the new generation is taught English as their second language so communication becomes easier in the future".*

This remark sheds light on both a barrier and an enabler. Language is a barrier. Russia doesn't use the same alphabet as in most Western countries and consequently communication problems are intensified between Russians and their foreign partners. It is, however, changing as also illustrated by the extensive use of the Internet as transfer mechanism for high-speed practices. Further, the remark above shows that continuation of the Russia 2002-2010 program's focus on bringing Internet access to Russia classrooms can be expected to be an enabler.

Second it is clear that many of the Internet software producing organizations in Russia are fairly young. They are also fairly small. These features suggest that the organizations are positioned right in the lower left corner of Greiner's model. These organizations are growing through creativity, and they can expect to meet the "crisis of leadership" in the nearer future. Consequently, a real barrier in a Russian context will be a sufficient supply of capable managers that can safely bring Russian software development companies forward into phase two. This is put in perspective by a remark from a respondent in BridgeOut:

> *"It is our experience in Russia that there is a lack of highly educated leaders".*

Unfortunately this barrier doesn't seem to be addressed at all in the Russia 2002-2010 program. A new key enabler will be needed to overcome this barrier in the near future.

Third, there are a larger number of foreign companies that have established themselves in outsourcing arrangements in Russia. One example is BridgeOut. In applying Greiner's model to the Russian companies it becomes clear that they will soon be growing through the direction phase. The quick growth of the Russian market – as aimed for by Russia 2002-2010 – will just as quickly lead to an autonomy crisis in many of the Russian companies. Again, the Russian organizations engaging in high-speed development of software lack key enablers to overcome this barrier. For example, carefully crafted legislation might enable a smooth transition from phase two to phase three in Greiner's model. Today, Russian contract law does not enable delegation of responsibility, especially in economic terms. A respondent at BridgeOut says:

> *"The Russian market is still immature. Of course you write a contract, but try to take that contract to court and you will find that your protection in a contract hardly can be trusted".*

The analysis using Greiner's model points to two near term barriers that lack key enablers for the future advance of companies developing software at high speed. First Russia is missing a source for better-prepared organizational managers for software companies. Second, Russia will need improvements, such as changes in their contract law, which enable companies to re-centralize their authority structures in the near future.

5 CONCLUSION AND FUTURE RESEARCH

High-speed software development uses a number of techniques to move software quickly into production. Clearly, many of these techniques were found in a case study of Russian Internet software houses. Using the Kline model of innovation diffusion and the Greiner model of evolution and growth of organizations we analyzed the enablers and barriers to diffusion of high-speed software development techniques in Russia, and found the following:

Enablers

1. Internet-based research
2. Rapidly developed knowledge through planned Internet expansion
3. Rapidly developing demands
4. A social norm against paying for copyrights unless there is associated revenue

5. Internet access in Russian classrooms can be expected to be an enabler

Barriers

1. Language is a barrier, slowly being overcome
2. Insufficient supply of capable software development organizational managers
3. Inability to centralize control over decentralized software development organizations

Future enablers needed

1. Expand Russia 2002-2010 initiative to include foreign language training
2. Improve training for software development organizational managers
3. Legislation is to enable a smooth transition from outsourcing agreements to more autonomous Russian software houses

Our study of the enablers and barriers to diffusion of high-speed software development techniques in Russia reveals a complex interaction of political, economic and technical elements that both enable and inhibit the development of knowledge necessary to support this case of innovation diffusion. This analysis permits us to understand how this diffusion occurs, and to suggest several future barriers and enablers that might be relevant in the near future.

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About the Authors

Jan Pries-Heje has a Ph.D. from Copenhagen Business School. He now works at The IT University of Copenhagen. From 2002 he is also Professor (part-time) at the IT-university in Gothenburg. His main research interests are information systems development, software engineering, and software process improvement. In particular he has carried out action research with industry on specific topics such as high-speed software development, IT project management, requirements specification, and successful organizational change with IT. He has published in these areas in journals like Journal of Accounting Management and Information Technology, IEEE Computer, The Data Base for Advances in Information Systems, European Journal of Information Systems, and Annals of Software Engineering. He can be reached by e-mail at jph@it-c.dk.

Richard L. Baskerville is professor of information systems and chairman in the Department of Computer Information Systems, College of Business Administration, Georgia State University. His research and authored works regard security of information systems, methods of information systems design and development, and the interaction of information systems and organizations. He is a Chartered Engineer, holds a B.S. *summa cum laude*, from The University of Maryland, and the M.Sc. and Ph.D. degrees from The London School of Economics, University of London. He can be reached by e-mail at baskerville@acm.org.

Galina Ianshina Hansen has a M.Sc. in economy from Moscow Technical University/State Institute of Roads and Automobile Transport.

She is presently a M.Sc. student at the Software Development Department at IT University, Copenhagen. Her research interests are in understanding software process maturity models as a change initiative that requires use of measurements of organizations ability to improve. She can be reached by e-mail at galina@it-c.dk.