# ORGANIZING STUDENT ENGINEERING DESIGN TEAM COLLABORATION WITH RUSSIA

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***Abstract* ¾ *For the last decade, economic conditions in Russia have had a severe impact on its universities – students, faculty members, infrastructure and facilities. There is still an enormous resource of talented and well-educated people in technical disciplines, but the process of establishing collaboration with them, while eased politically, is very difficult from a practical point of view. Western partners must assist them in gaining access to the necessary resources, including communications, hardware, and software. Lessons learned and methods developed to improve the productivity of US/Russian student teams working on industry-sponsored engineering design problems are reported here, with the goal of assisting others to engage in this type of activity.***

*Index Terms* ¾ *globally distributed teams, computer-supported collaborative work, US/Russian teams, student design teams.*

## BACKGROUND

In 1996, an interdisciplinary team of faculty members in engineering and telecommunications (soon broadened to include anthropology) at Michigan State University began studying globally distributed teams engaged in engineering design, under sponsorship from a global provider of telecommunications and systems integration services. A grant from the National Science Foundation in 1998 ("Internationally Networked Teams for Engineering Design – INTEnD" [1] extended this work. Students at MSU were recruited to participate in a senior-level design course – initially as a "global" option in a required capstone design course, and later as new design elective when the inflexibility of the required capstone proved to be too restrictive to allow for the integration of activities between universities with different semester lengths, starting dates, vacation periods, etc. MSU students were drawn largely from mechanical engineering, although students from electrical engineering, computer engineering, and computer science majors have also participated. Sometimes teams also included a telecommunications student, who received credit for a course in telecommunications, and whose role was not to participate in the engineering design process, but to act as a facilitator, trainer, and problem solver for the use of the videoconferencing and other media. A few teams also included an anthropology student as an observer, helping to gather data for the study of the groups' work processes and interactions.

A second NSF grant beginning in February, 2001, will support continued work with distributed design teams, among other activities, but with a focus on the border region of Texas and Mexico. The activity reported here, however, involving collaboration with a Russian university, all occurred between spring, 1999 and fall, 2000.

The first author has visited Russia and/or Ukraine about once per year since 1991, primarily to establish and engage in research collaboration in genetic algorithms. Several joint projects involving colleagues in universities in Moscow, Volgograd, Nizhny Novgorod, and St. Petersburg (Russia) and in Kiev and Dneprodzerzhinsk (Ukraine) have been carried out – some sponsored by U.S. industry (but administered through Michigan State University). As a result of this activity, and others by the other authors, the INTEnD faculty team at MSU has established good working relationships with many colleagues in Russia and Ukraine. Therefore, when the opportunity to establish globally distributed student teams arose under the INTEnD project, a faculty member in St. Petersburg, Russia, was chosen as a logical partner.

The INTEnD project is predicated on the industrial sponsor of each project paying for the student team's communications and supplies expenses, and in the cases of teams with students in Netherlands, Germany, Spain, Mexico, and Singapore, that concept has worked well. Sponsorship typically costs the industrial sponsor a few thousand dollars, at which level it is not difficult to recruit projects from them. A joint team with China required additional financial resources to establish, and greater expenditure of faculty effort, as has each of our joint teams with Russia, as described below.

Many of the projects provided by the industrial sponsors could have been done with teams distributed between the U.S. and any other country, but several projects from Ford Motor Co. were particularly appropriate for joint U.S./Russian teams because they involved design of

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manufacturing equipment to be introduced into a new Ford factory near St. Petersburg, Russia, the home of our Russian participants. One project involved wheel flange forming, and another concerned roof welding. Understanding the differences in resources, labor costs, production volumes, etc., between automotive plants in Russia and the U.S., and maintaining product quality in a very different environment, became both a challenge and a learning platform for the students on both ends. Other projects included design of a storage device for robot end effectors, of a wax-based thermal actuator, of software for deriving geometric properties for finite element analysis, of a veterinary intensive care unit, and of process improvements to minimize brake rotor runout.

## THE INTEND INFRASTRUCTURE

As a result of work with a sequence of distributed team projects, the INTEnD research team has developed organizational principles, teaching modules, and a software infrastructure as ways of both supporting the work of distributed teams and of observing and documenting their activities. We have reported many observations about the difficulties encountered in teamwork of people working together without regular face-to-face contact, or, as in our case, without ever having met face-to-face [2] [3], as have many others {4] – [11]. Problems are more severe when the teams are divided not only spatially, but also by:

- Time-zone differences
- Language differences
- Cultural differences
- Multiple disciplines
- Project calendar differences

In order to address these issues, students participating in the teams organized under the INTEnD project have received a) lecture- and web-based exposure to the issues, and b) the guidance of faculty supervisors experienced in global team collaboration, who have met at least weekly with student members in each location (i.e., MSU students met with an MSU faculty member, and students in Russia met with a Russian faculty member).

Lecture material and web-based assignments have helped to sensitize the students to common problems encountered in interaction of distributed team members with different expectations, languages, cultural and educational backgrounds. All lectures given to the U.S. students are videotaped, sequenced with the screen presentation materials, and put onto the web through MSU's Virtual University. Students see the speaker or the MSU classroom, while simultaneously seeing the presentation materials the MSU students are viewing. All student team members from other universities are enrolled (for 0 credits, at no cost) in the MSU VU course EGR 475, Global Design Teams, to give them access to the lectures through the Virtual University. For students in China and Russia, because of high cost of internet access, we copy the lectures to CD and send them to the supervising faculty member. Lecture topics include project management, oral and written presentation of design material, sensitization to cultural differences, and other topics.

However, we have found another factor to be more important than the content of the lectures. For building of mutual understanding, trust, and respect within the distributed team, regular use of videoconferencing is very important. Its use has correlated strongly with the quality of the team's performance. Teams which made extensive use of videoconferencing were seen to function much better jointly – especially when the videoconferencing included not only technical discussions, but also informal talk about the team members, their universities, their families, their outside activities, their likes and dislikes in music and films, etc. Much as informal social interactions are recognized to be a key factor in business relationships, this same factor, through the medium of videoconferencing, has proved to be important for the success of virtual teams. Thus, in spite of the cost of global communications, the faculty advisors have encouraged the student team members to spend some of their videoconferencing time informally, getting to know their teammates. There is sometimes a conceptual barrier to be overcome, as team members very aware of the cost of video communication sometimes want to "get down to business," and are reluctant to recognize the value and real work of teambuilding.

## COMMON PROBLEMS OF TEAMS

During supervision of early collaborative projects, the faculty supervisors frequently observed two phenomena: 1) students had difficulty discussing design documents being jointly developed, and 2) one half of the team was often unsure whether the other half had received materials they had sent by email, or had read them, or had done any work based upon them. It was not uncommon for members in one location to decide, faced with no communication from the other location for several days or longer, that the other side simply wasn't doing anything. This phenomenon had a strong negative effect on the motivation of the team members, causing resentment and discouragement.

## VIDEOCONFERENCING NEEDS AND PITFALLS

The INTEnD researchers experimented for several years with a variety of tools to facilitate distributed team communication, including web-based videoconferencing, videoconferencing on ordinary ("POTS") telephone lines, ISDN-based videoconferencing at various line speeds, and use of tools for web-based application sharing. While all of those tools were found to support video at some level, none was able to provide a usable quality of voice communication between students abroad and those in the U.S. The technology ultimately adopted for most teams used a pair of ISDN channels (total 128kbs) for a combination of video, audio, and application sharing. Costs for this type of videoconferencing, depending on destination, ranged up to hundreds of dollars/hour.

Establishment of the needed ISDN services in the laboratory of our Russian partner turned out to be problematic. An initial attempt to establish ISDN service at the university netted a "last mile" cost of many thousands of dollars, so was not feasible. A private company providing ISDN service to customers in St. Petersburg through Helsinki, Finland, was located, and the initial pricing and monthly and hourly rates for use appeared to be reasonable. However, in response to delays in arranging the necessary contract and payment terms, the first author finally felt it necessary to go to St. Petersburg to visit the ISDN service provider and sign the contracts personally. However, to his surprise, after the company went over the contract terms with him, they were unwilling for the contract to be finalized at that point, and, in fact, service was not actually established until nearly six months later. In addition, a significant amount of testing was required before satisfactory service was achieved. However, the service ultimately proved to be of high quality and reliability. Monthly payment for the "basic service" is now made in Russia, with the cost reimbursed by the U.S. participants. All calls are initiated (and hourly charges paid) from the U.S. end.

### Special Needs for Russian Participation

In order to make the necessary communication possible, the researchers provided not only the ISDN lines, but also the videoconferencing equipment (microcomputer boards, two cameras), a PC, and a fax machine to the laboratory in St. Petersburg.

However, facilities were not the only special funding requirement in order to support partnership with Russian students. Because of the dire financial situation of both students and faculty members in Russia, a small amount of funding was also provided to the supervising faculty member to compensate him for his time and to provide small stipends for the student participants. Without these funds, it is very difficult for either students or faculty members to participate, because they must otherwise spend a great deal of their time and attention simply finding ways to meet their basic needs for survival, through working second and third jobs, buying and selling goods, etc.

Commonality of the engineering and project management software to be used by the students was also required in order to increase team effectiveness. The US partner furnished a license for the project management software to be used, and worked with a U.S. vendor of CAD/CAM/CAE software to arrange for an educational license for the software to be provided to the Russian partner, for a limited period, at no cost to the partner. While it is routine for U.S. universities to obtain free or nearly free licenses for many proprietary engineering software packages, the situation is very different in Russia, where the legal system and protection for intellectual property are less well developed. For that reason, even some of the U.S. firms that market their software products in Russia are reluctant to provide low-cost or free licenses for use in universities, perhaps because of a fear that they may be used for commercial as well as educational purposes. Aggressive lobbying by the U.S. partner may help to overcome this hurdle sufficiently for the needs of a joint project, but the differences from the situation in U.S. universities must be acknowledged.

## FACILITATING SHARING OF INFORMATION AND AWARENESS OF EFFORTS

In many cases outside the U.S. and Western Europe, computers – even "servers" – are not left running 24 hours/day. This caused severe problems for some of our early teams, driving us to seek an environment in which all team members would have access to shared filespace, but without the need to run specialized client software. In addition, se sought to make our team members aware of all activities involving shared documents, wherever and whenever they might occur. Therefore, we developed TeamSCOPE, a Linux-based server package that provides these services to any authorized team member, through any internet browser client. To set up a team, an administrator enters a username and initial password for each member of a team, and that establishes a virtual site at which the team members may upload and download documents, post and respond to comments about documents, schedule meetings and videoconferences, reserve facilities, and be notified of any or all actions performed on any object at the team site. That is, for example, a team member may choose to be notified by email whenever any other team member reads or downloads or modifies a shared document. In an environment in which email delivery is not reliable and often must at least await rebooting of a server on a Monday morning, TeamSCOPE provided instead a reliable and timely way of interacting – even when an email server was down, a student could log into TeamSCOPE and check interactively the status of all logged activities.

Of course, the use of TeamSCOPE also provided our research team a wealth of detailed information about the teams' patterns of electronic communication, although only header information, not message or document content, was made available to the researchers, in order to safeguard the privacy of the team members.

The researchers plan to make a downloadable version of the TeamSCOPE server available under the GNU General Public License in the near future, pending legal approval from the university. This will enable others to establish their own servers, on any machine running the Linux operating system. However, from the point of view of users, no specialized client software is required to use TeamSCOPE – a Linux machine with the TeamSCOPE download is needed only to become a new provider of TeamSCOPE services.

## FUTURE DIRECTIONS PLANNED

The authors plan to continue supervising the work of a large number of globally distributed student engineering design teams. Employers of our graduates enthusiastically support the program, including sponsorship of team (providing design problems, a contact person, and funding for expenses). However, under our new NSF support, our emphasis will be on bridging gaps with firms and students on the Texas/Mexico border. However, we will continue to have some teams collaborate with Russian students, because of the great value of the experience to our students, the valuable experience it provides to the Russian participants, and the desire to continue fostering technical collaboration with our Russian colleagues.

For the last three years, the INTEnD program has been seen by the authors as a prelude to a much larger program called NEWTeams – Networked East/West Teams for Engineering Design. The NEWTeams concept is to allow engineers living in Russia's closed nuclear cities to work as consultants to U.S. companies on non-defense-related design projects. The program was proposed to the Nuclear Cities Initiative ("NCI"), a nuclear non-proliferation program of the U.S. Dept. of Energy, established via a bilateral agreement with the Russian Ministry of Atomic Energy (Minatom). Under the NEWTeams concept, the Russian engineers would first be trained in using U.S. CAD/CAM/CAE systems, design and quality standards, and in working with Americans, by participating in design team projects with students at MSU, University of Utah, and other engineering schools, using the tools and methods developed in the INTEnD program. Of course, that would also provide valuable global team experience to the U.S. participants. Then, after completing the team experience, the Russian engineers would become eligible for employment using NEWTeams facilities in laboratories in the non-classified sectors of their closed cities. To a U.S. company, NEWTeams would look like other consulting firms using off-shore engineers – a supply of engineering talent in a market in which that is in short supply.

However, the NCI program funding was reduced sharply from that originally envisioned – aid to Russia has received very mixed support in the U.S. Congress in recent years. Therefore, funding of NEWTeams has not been obtained, and the team at MSU is no longer actively seeking it. We hope that others will see the worth and promise of this concept and pursue it to fruition.

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