

Rajkumar Roy, Victor Taratoukhine

# Decision Engineering: Informed Operational and Business Decision Making within Industry

The findings from a high technology mission to Russia



Sponsored by UK Department of Trade and Industry **dti**



## **This report**

This is the report resulting from a high technology mission to Russia to evaluate opportunities in decision engineering areas in Russian Academia and Industry.

## **List of Mission Participants**

Roger Annett	Elbrus Technologies Ltd
Dr Ben Azvine	BTexact Technologies
Nigel Buttrick	The Association of Cost Engineers
Gareth Evans	CORUS Rail Technologies
Dr Rajkumar Roy	Cranfield University
Mark Stenson	Rolls Royce
Dr Victor Taratoukhine	Cranfield University

## **Acknowledgements**

This report has been produced by Dr Rajkumar Roy and Dr Victor Taratoukhine from contributions written by all members of the mission team.

The contents of this report reflect the views of authors and not those of the Cranfield University or any other organisation represented in the Department of Trade and Industry sponsored visit.

First published July 2002  
ISBN 1 871315 81 6  
© Cranfield University

Tupolev TU-204, Tupolev TU-334  
and AviaStar images printed with permission from  
Sirocco Aerospace International Russia.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form without the prior written permission of the publisher, nor be otherwise circulated in any form of binding or cover other than in which it is published and without similar condition being imposed on the subsequent purchaser.

# Contents

Foreword	2
Notes from Mission Manager	2
Executive summary	3
Introduction	4
Objectives	4
Target Country	5
Decision Engineering in Russia	6
<i>Research and Academic Institutions</i>	6
<i>Russian Companies</i>	6
Specific comments in the areas of Decision engineering	8
<i>Intelligent Systems</i>	8
<i>Cost Engineering</i>	9
Institutions and Companies visited	11
<i>Universities and Research Centres</i>	11
<i>Companies visited</i>	13
Opportunities for British Companies	18
The way forward	19
Appendices	20
<i>Contact details</i>	20
<i>Web-based Information resources</i>	21

# Foreword



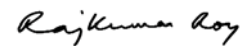
Decision Engineering is an emerging discipline that aims to develop tools and techniques for informed operational and business decision making within industry by utilising distributed organisational knowledge and data. The tools and techniques are aimed to assist in making smart decisions quicker. Cranfield University is very active in this area of research and development. Industrial partners of the mission are either actively using such techniques or have a major stake in promoting such tools.

To survive in the Global economy it is necessary for the British Industries to remain competitive and be flexible. British industries can benefit in expanding business in Russia to enhance competitiveness and the association can also help in exploiting Russian talent in Science and Technology in the Global market.

With the DTI support, the Mission has provided the required opportunity for the British Companies to acquire a first hand experience about Russian opportunities. Some of the participating companies and organisations have already expressed interest to explore the next step in developing future collaboration.

Cranfield leadership is promising an environment for regular interaction between the British Companies with their Russian counterparts in Decision Engineering areas. The dissemination workshop on the 28th July and Virtual Discussion event in November will take the mission into the next step.

Cranfield  
5th July 2002



Dr Rajkumar Roy  
*Academic Leader*

---

## Notes from the Mission Manager



First of all I would like to thank our mission members for their active participation in this event.

Very special thanks are due both to DTI International Technology Promoter for Russia, Juan Matthews and Assistant International Technology Promoter at the British Embassy in Moscow, Dimitri Popolov.

This mission was made possible with the support and financial assistance of the Department of Trade and Industry (DTI) International Technology Service. Special thanks are also extended to the Staff of the British Embassy in Moscow and British Consulate General, St. Petersburg.

A brief description of all the organisations visited is included in this report. Each visit was exceptionally valuable, and I would like to thank all of the people for their participation in this mission.

Cranfield  
5th July 2002



Dr Victor Taratoukhine  
*Mission Manager*

# Executive Summary



**The Mission Team with Digital Design Company Staff, St. Petersburg**

Decision Engineering is an emerging discipline that aims to develop tools and techniques for informed operational and business decision making within industry by utilising distributed organisational knowledge and data.

The mission in Decision Engineering focuses on three main areas: cost engineering, intelligent systems and knowledge capture and re-use. The subject areas of mission were: Cost Estimation and Cost Engineering in Aerospace, Transport, Oil and Gas Industry; Knowledge Capture and Reuse; Intelligent Systems application in Industry for decision making and collaboration. The aim of the mission is to explore any opportunity in Decision Engineering areas in Russia for the British Industry.

Accompanied by representatives from Cranfield University, Rolls Royce, BTextact, Corus Rail, Elbrus Technologies Ltd, the Association of Cost Engineers, and the DTI International Technology Promoter for Russia, Juan Matthews the mission team set itself the primary task of identifying the level of development and use of these technologies in Russia.

Arranged with the help of the British Consulate General in St Petersburg and the Assistant International Technology Promoter at the British Embassy in Moscow, Dimitri Popolov, the group's itinerary included visits to Moscow State University, the Russian Academy of Sciences, St Petersburg State Technical University, the Ioffe Institute, the Aerospace Devices University and a range of large and small companies including Tupolev, Aviation Euro-Russian Consortium, LUXOFT, Petrocom, EPAM Systems, BeePitron and Digital Design.

It is observed that Russian academic institutions are going through a transition to collaborate with commercial organisations and industry. The wealth of knowledge and motivation for research are very high. With Russian globalisation and cheaper cost base the researchers in intelligent systems and software development provide good opportunity for the British Industry.

Russian industries are becoming more flexible and many of them are strongly motivated to enter the Global market. Highly skilled software professionals at low cost and a smaller, and agile management structure provide lucrative outsourcing opportunities for the British companies. In the areas of Cost Engineering and organisational knowledge capture and reuse through system development, there are opportunities to sell British skill and experience to Russia. Overall the mission was a great success and the team is strongly motivated to pursue some of the opportunities in the future.

# Introduction

Manufacturing industries striving for success in an increasingly competitive and fast-moving world know that those capable of making swifter, smarter decisions about everything from design to logistics to processes are going to have the edge. The outcome of those decisions is all around us as we see the results of the design from the concept to the manufacture and beyond. However, those engineering decisions are frequently based upon many different criteria, such as the product must be able to perform the function for which it is designed to do. It must also be reliable and have a life expectancy, it should be the right size, the right weight, maybe it needs to have the right aesthetics. So it's not surprising that the development of tools and techniques for informed operational and business decision making is a top priority for researchers and industrialists in many sectors. Decision Engineering is a specialisation that incorporates the tools and techniques to make smart decisions quicker. The main focus of the mission is in the areas of intelligent systems, cost engineering and knowledge capture and reuse techniques and tools.

This report has been produced following the recent Department of Trade and Industry sponsored technology mission to Russia (19th - 25th May 2002) on the subject of Decision Engineering. Members of the mission came from a number of backgrounds and represented different themes with regard to the field of Decision Engineering. This is in line with the Decision Engineering Research and Education at Cranfield University, lead by Dr. Rajkumar Roy.

The aim of the mission was to appraise the status of this subject area in Russian academic and industrial institutes with a view to sharing current UK methods and practice and to look for opportunities for future collaboration. As a means of maximising the visit two key locations were attended: Moscow and St Petersburg.

## Objectives

The objectives of the study were to:

1. To identify the level of technologies used in Decision Engineering within Russian aerospace, transport and oil and gas sectors.
2. To understand the business model of co-operation between UK and Russian Companies and academic institutions for future financial benefits.
3. To improve the competitiveness of UK industry by making it more aware of development in management of best practice in Decision Engineering in the Russian Federation.

# Target Country

***‘The scientific expertise in Russia is second to none, particularly in the field of basic science such as Maths, Physics and Chemistry’.***

***Lord Sainsbury of Turville, Parliamentary Under Secretary of State for Science and Innovation***

Since 1991, scientific research in Russia has suffered from a major funding crisis in which state-funded science research has reduced from 1% to 0.32% of GNP. Also, up to 30,000 scientists have moved to the West.

However, in the last two years the areas of science and technology have received the promised levels of funding from the state and the Russian government is exploring ways of promoting further support for research. The Russian economy is growing at around 7% p.a. and one of the greatest challenges facing the current administration is how to sustain such a rate. The government is using these conditions to drive economic change and sustain growth, using legislation, de-regulation, and reform of monopoly industries such as oil, gas, electricity, and railways.

Other main issues for the Russian economy are tax reform, land reform, focus on SME's and Banking reform. The economic programme for reform has strong backing from the top leadership in Russia who are committed to modernisation of financial and industrial infrastructure of the country.

During the ‘Britain and Russia: Partners for the Information Age’ workshop, DTI Conference Centre, London, October 29, 2001, Lord Sainsbury of Turville, Parliamentary Under-Secretary of State for Science and Innovation mentioned:

‘The scientific expertise in Russia is second to none, particularly in the field of basic science such as Maths, Physics and Chemistry’.

In his presentation to the Mission, Simon Evans the First Secretary (Science) of British Embassy, Moscow informed that the Russian Federation has 400,000 researchers in 4,000 institutions. At the present, 80% of state-funded research in Russia is conducted in research institutes affiliated with the Russian Academy of Sciences (RAS) and the remaining 20% in universities. The research institutes are often the ‘heart’ of purpose built scientific cities, of which there are around 60 such examples in Russia, e.g. Zhukovsky, a city of

200,000 people built around an air field and specialising in aeronautics.

The universities and academic institutes are aimed at delivering traditional technical subjects that are underpinned by strong mathematics and physics whereas the UK institutes have for some years been diluting these core subjects in order to provide a large dose of business acumen for their technical students.

The fast growing area of R&D in Russia is on telecommunications and information technology, seen as growth markets with greater potential for exploitation in the West.

# Decision Engineering in Russia



*Moscow State University at night*

## Research and Academic Institutions

During visits to the six academic institutions in the programme it was clear that there is a significant difference in the experience and approach of the organisations to Decision Engineering research.

The Faculty of Computational Mathematics at Moscow State University (MSU) has links to Microsoft and Intel (both donated hardware to the faculty) and has collaborated with 200 universities inside Russia and 15 universities globally (USA, Germany, France, Singapore, Japan, China). However, university research appears to be highly theoretical and links with industry are not strong - work is carried out on a contract-by-contract basis, e.g. in the oil/gas sector. The university acknowledges it needs to work at increasing funding from industry to enhance its current activity levels.

In the decision engineering areas MSU offers rational solutions in economics and assessment, also decision support for tax (& insurance, 15 actuaries have graduated), through rocketry & Sukhoi aircraft design.

Professor Alexander V. Lotov made a stimulating presentation of Visualisation in decision support (environment, engineering management), involving both MSU and the Russian Academy of Sciences, with an 'input/model/pictures' structure.

Bauman Moscow State Technical University is highly regarded in Russia as the top university for applied science. The Department for Computer Integrated Manufacturing has worked widely with Russian manufacturing, warehousing, banking, and logistics sectors. The Department of Information Systems has worked for GAZPROM, the largest gas provider in the world, conducting feasibility studies of projects. All this is in the heartland of decision engineering.

St. Petersburg State Technical University has more experience of decision engineering techniques, being involved with the fields of AI and Intelligent Systems at the Faculty of Engineering Cybernetics. Links to foreign universities and businesses (e.g. Phillips, GE, ABB, Siemens) are also more developed than at MSU.



*St. Petersburg State Technical University Institute for Robotics and Technical Cybernetics  
The adaptive walking robot*

Young students are learning English language and use it with confidence. Senior academics are still more comfortable in writing and speaking in Russian.

## Russian Companies

There are two aspects here, one the extent to which Russian companies require and use decision engineering concepts, and the other how well placed they are to develop the necessary technology and infrastructure in the future. Firstly there is little evidence based on the companies we visited that there is a well defined approach to decision engineering in Russian industry. The current approach is very much based on human expertise and experience. However most companies recognise the need for systems and processes to support and formalise the decision making process particularly those decisions regarding life cycle costs. On the second issue the move towards a free market economy and the increasing need for Russian companies to become competitive both domestically and internationally has led to a need for better IT infrastructure. In response to this there are now a number of software companies well placed to offer the IT infrastructure needed to enable knowledge capture and re-use for decision engineering in the Russian industry. So there is clearly an opportunity for Western experts in this area to form



*St. Petersburg State Technical University  
Onboard manipulation system*





**Digital Design Company  
Software Lab**

collaborations and partnerships with their Russian counterparts to offer consultancy, training courses and joint product development in order to facilitate technology transfer when the infrastructure is in place.

The shining light in Russia today is the emergence of Western style software companies who, in recognising the need to attract Western customers, have adopted the necessary disciplines. The software companies tended to be young organisations (<10 years old) with a dynamic approach to the opportunities available in Russia and across the globe. Most of the software developers could quote an impressive-sounding list of clients. Often led by entrepreneurs educated in the West, they are able to offer IT services and software development to the West but by taking advantage of much reduced labour rates from the East. In this way they can offer comparable capability as they use the same accreditation pedigree yet at significantly more affordable rates. This has to be the standard to be attained by the more traditional industries in Russia.



**A small thank you to Professor Boris Babayan (left), Elbrus Company, Moscow from Dr Rajkumar Roy (right)**

The companies visited were focussed primarily on computer software development (with the exception of Elbrus Technologies and the aerospace organisations).

Using Decision Engineering components such as rule engines and Star Reporter, a tool for multi-dimensional analysis, EPAM Company has produced Decision Engineering web-based solutions such as the Project Management Centre, and the Executive Decision Support system for Bally.

There was only limited evidence of other software companies using Decision Engineering techniques to provide solutions for clients. However, as with the universities, there is immense talent within these young, growing businesses and this potential should reap significant benefits as the companies continue to expand in a very competitive market. There would not seem to be any particular barriers preventing the companies we visited from exploiting Decision Engineering methods if customers demanded such solutions.

The knock-on effect is that research into such management techniques also remains unrecognised whilst many of the conceptual mechanisms for their implementation have been developed, e.g. artificial neural networks, fuzzy logic, mathematical modelling and simulation. Predominantly such techniques have continued to be applied to technological advancement and not to decision making or business practice such as Cost Engineering.

From evidence gathered on the Mission it was evident that in Russian universities and companies there is a good deal of experience in Decision Engineering, but there is no established Decision Engineering discipline as such. But the activity “decision support” is certainly recognised.

# Specific comments in the areas of Decision Engineering

## Intelligent Systems

The subset of institutions visited during the mission who have or are positioned to have technologies to enhance the status of intelligent data analysis or intelligent information management in the near future in Russia are described in this section.

By intelligent systems we mean systems that exhibit some form of intelligent behaviour such as pattern recognition, adaptivity, autonomy, collaboration. There are two subsets of intelligent software systems relevant to decision engineering based on the type of underlying data available. If data is in structured form such as those found in large databases then we refer to this area as data analysis and the technologies as Intelligent Data Analysis. There is however another form of data referred to as unstructured data including documents, emails, most information on corporate intranets and the Internet. Such data requires information management technology and intelligent systems for these data types will be referred to as intelligent information management.

The most impressive and relevant academic institute visited from the information technology view point was the Institute of System Programming. It has worked on several R&D projects broadly described as belonging to two areas:

- Parallel and distributed programming
- Integration technologies of information resources

In information technology there has been work in several projects of interest to information management such as:

- Business process management
- Object-based technology for distributed information systems

The current research projects focus in the area of data analysis on the following:

- Virtual approach to data warehousing

- Multidimensional view of virtual data
- Data mining from semi-structured data
- Web-usage mining

The Institute of Systems Programming at the Russian Academy of Sciences has applied neural network techniques to applications such as satellite stabilisation systems, active suspension control in motor vehicles, and economic forecasting. The institute is currently awaiting publication of papers covering a range of subjects such as a virtual approach to data warehousing, multidimensional views of data, data mining from semi-structured data, and web-usage mining.

Elbrus Group. Decision Engineering is the foundation of its business, but the terminology is not recognised as such – it is just a given that its design and business decisions are supported by qualitative and quantitative data. Risk analysis is widely used – Professor Boris Babayan reckons that 50% of the World's risk analysis programmes are written in Russia. However, software cost engineering is lacking and very much needed, particularly in estimating costs for its contracts in the West. This need is recognised.

LUXOFT company has experience in projects involving the following objectives relevant to decision engineering:

- Design and developing work flow mechanism;
- Automation of financial analysis and planning processes;
- Integration of information systems;
- STAR SPB Ltd. STAR's specialises in development of Knowledge Management and Data Mining tools which implement advanced language engineering techniques. The company has expertise mainly in the intelligent information management area particularly in
  - Natural language engineering. Development of large-scale linguistic resources, tools for language analysis and generation, linguistic processors



**Cluster High Speed Computer, Institute for System Programming of the Russian Academy of Sciences**



**The Mission Team in Moscow**

- Knowledge engineering. Construction of ontologies and knowledge bases, knowledge inference, text data mining

The company has worked on two projects of particular interest. The SwissSearch project focused on the automatic construction of a thesaurus using the data from a structured information database (DB). The TextWizard system is developing techniques that use a knowledge of concepts and their interrelationships to find correspondences between the concepts in users' requests and those that occur in text passages. Its primary goal is to improve the convenience and effectiveness of online information access.

The above observations are also true in most of the other visited companies. However this conclusion is made from an extremely small sample in that just four engineering companies or consortia were visited. The software firms visited were offering Intelligent Systems applications mostly to domestic customers, but increasingly to industrial companies outside the Russian Federation. We think the software industry needs consolidation to develop larger players to compete in the Global market.

### **Cost Engineering**

Since the collapse of the Soviet Union the desperate need for economic reform is slow as is the reaction of their traditional companies to the opportunities of a free market. The result appears to be an industry with latent manufacturing capability and an abundance of capacity yet an absence of managerial ability to create value from such necessary factors. Certainly the need to attract the attention of new customers generating revenue for investment to create further value has never been more obvious.

In general, Russian industry has suffered from not having an obligation to maintain competitive advantage as this stimulates the need for behavioural as well as technological advancement. Including other methods now common place in Western

business, Cost Engineering has to date failed to be recognised as an essential tool for managing business within Russian Industries.

Recognising that cost and value play an increasing role in today's business environment, Rolls Royce has made considerable investment in its cost estimation and analysis methods to support those needs. The focus for this investment has mainly been in support of its Purchasing function due to the nature of the business being largely out-sourced. The need is further stimulated by the nature of the product whereby a legacy production system can attract potential sales decades after their original launch providing they remain competitive in all areas. The need for ongoing cost reduction then remains throughout the product lifecycle. If Russian companies want to interact with the Western companies they need to adopt the Cost Engineering practices.

This provides a clear focus for strategic costing activity in working with its supply chain to ensure competitive products which continue to attract new and existing customers and to simultaneously contribute to bottom line profit through the consolidation of sales through increasing value.

Strategic cost methods are therefore developed to support two key business requirements:

1. Improving value by ensuring purchased products are competitively priced at current economic and market rates. For this the processes of should-cost modelling and parametric benchmarking have been introduced.
2. Improving value by working with key suppliers on continuous improvement programmes, driving out costs together through product and process improvements. For this the process of supplier cost modelling has been introduced. It is important for the British companies to appreciate the cost base for the Russian suppliers for the cost modelling.

The Association of Cost Engineers (ACostE) says that the Cost Engineer

'...is by education, training, and experience, competent to develop and make practical use of the principles of engineering cost management which embraces activities such as estimating, cost control, planning, construction management, investment appraisal and risk analysis'.

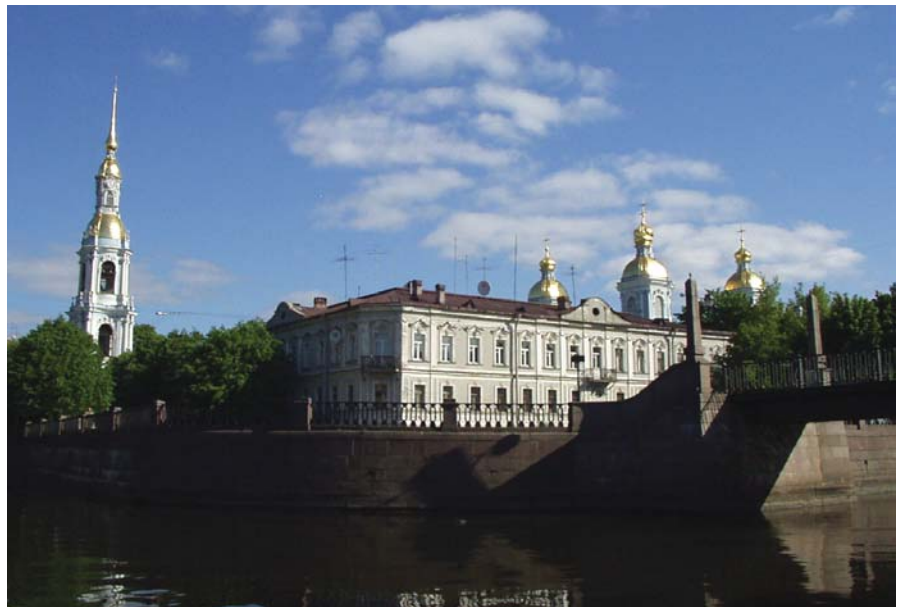
Decision Engineering could arguably be described as an expansion of the role of the Cost Engineer to include complimentary tools and techniques such as knowledge capture, integrated logistics, concurrent engineering, earned value management, manufacturing enterprise systems, manufacturing technology etc.

The Cost Engineer is a key player in any engineering factory that desires profit. As no factory can survive without this, the skills

offered by the Cost Engineer are in great demand in a market economy. It is the market that drives the economy and Russia must now meet the demands of the market. But, how does a factory in Russia obtain the necessary skills to meet these relatively new challenges?

To pursue the above objectives requires a large fraternity of like-minded professionals. Unfortunately, this evolution will take many years to establish from scratch, which is the situation facing Russian Industry. However, the internet and communication channels do offer the practising Russian Cost Engineer the opportunity to share best practice with thousands of western based colleagues.

This is an opportunity for ACostE to promote the association and expand into the huge market opportunity that resides in Russia.



*Naval Cathedral of St. Nicholas, St. Petersburg*

# Institutions and Companies visited



**Professor Evgeny Moiseev, the Dean of Faculty of Cybernetics of Moscow State University**

## Universities and Research Centres

### Moscow State University

The Mission was hosted by the Faculty of Computational Maths & Cybernetics.

Moscow State University was founded in 1755 and has special status in the Russian Federation being self-governing. Currently, there are more than 40,000 students supported by some 9,000 teaching staff. The State University has close relationships with the Russian Academy of Sciences. The university will offer all students a standard five-year training course plus an additional extended year to specialise in Engineering. Russian industry demands engineers and many students will continue for a further three to four years and complete a PhD making their period at university almost ten years.



**Bauman Moscow State Technical University Main Building**

### Bauman Moscow State Technical University

Prof. Gennady P. Pavlikhin (Vice Rector for International Relations) and his colleagues presented a University established in 1830 and now with 18,000 engineering students, with a further 1,000 post-graduate. There are seven research institutes, and international relations with 40 other institutes.

The University offers engineering graduate courses of 5 & 6 years, and since 1992 a multi-level (sandwich) course.

Prof Victor Emelyanov presented the Computer Integrated Manufacturing (CIM) Department. This was founded 15 years ago, for the Soviet machine building industry. Nowadays they offer computer engineers & technicians for large-scale industry – pulp, paper, lumber, resins & plastics – the office, and banking. Urban transportation systems are also a speciality.

The RAO simulation language developed in CIM Department is based on the RAO (resources - actions - operations) method of representing knowledge about discrete processes. For describing complex discrete systems and processes, the RAO method uses modified production rules. This is

possible because of similarities between the main concepts of simulation and production rules – system state and state change.



**Professor Igor Norenkov is presenting Computer Aided Design Lab of Bauman Moscow State Technical University**

The RAO simulator may be used for building simulation models, planning systems, games and training facilities. Traditional production rules are just a particular case of modified rules, so they too may be written in the RAO language and used for deduction. So the RAO simulator may be used for expert systems and hybrid systems uniting expert systems, multi-agent methodology, simulation models and optimisation algorithms.

A spin-off from CIM Department, SPRUT-Technology Company is a leading Russian company in the area of development of knowledge based CAD/CAM/PDM Systems. The SprutCAM software tool allows performing machining of parts on higher complexity level. The process of machining of details is defined by the regulated sequence of technological operations. All technological actions of the current project are included into a list of operations.

Research into distributed information systems and banking security involves co-operation with De Montfort University. Other applications worked on include: evaluation of development capacity of Russian Regions; with GAZPROM Bank the evaluation & introduction of venture projects, with a feasibility study for Europe; multi-agent systems – cascade (80s technology) & spiral (latest technology).

Professor Norenkov presented Computer Aided Design Department. All students of Bauman Moscow State Technical University have been trained using these CAD methods since 1983 (graduates from 1987). Apart from classroom teaching the department offers distance learning, with electronic textbooks & simulation to international standards. There is research into genetic algorithms for graphic systems for logistics & design problems, with heuristics & dynamic scheduling.

### **Institute for System Programming, Russia Academy of Sciences**

The institute for system programming of Russian Academy of Sciences (ISP RAS) was created on January 25, 1994 from Departments of system programming and discrete mathematics formerly of the Institute of Cybernetics Problems of RAS. The institute is associated with Moscow State University and therefore can select high quality PhD students to work as research assistants. The mission of the institute is to support research, development and education. In 2001 it attracted \$2.5 M funding, 80% of which was provided by industrial contracts, 15% from state and other academic institutions. Its main stated objective is to develop highly specialised people in industrial areas of research.

Prof. Dr Victor P. Ivannikov, Director, presented a wide spectrum of concepts and products.

Strengths are in forecasting (economics for Siberia Region), research & development & education (70 alumni have left Russia but still in contact) and XML technology for systems integration – real-life needs.

The Institute collaborates with India, France and Rutherford Appleton Labs (RAL) in UK. They have a project with 'EvanDax' of Cambridge, UK, for developing CRM systems scalability and with Nortel Networks on the Protel-2 ORB Open Node. A beta version of BizQuery Server Design is under development with ATS (who own the IPR). They compete generally in the data warehouse segment.

The Institute obviously works in the area of Decision Engineering – but the terminology was not recognised by the Directors.



**Professor Victor Ivannikov, Dr Rajkumar Roy and Dr Victor Taratoukhine at Institute for System Programming**

### **St Petersburg State Technical University (SPbSTU)**

Professor Vadim V. Korablev, Vice-Rector & Head of International Relations Administration, presented the University, founded in 1899. There are 26,000 students, and 450 full-time professors together with 1200 affiliated. There are 800 researchers. The 18 faculties include Physics & Maths, Industry, Economy & Management, and Medical & Biology. There is direct co-operation with Russian Academy of Sciences, and Ioffe Institute (see below). Co-operation in UK is with UMIST, UCLondon & Hull University.



**The Mission Team at St. Petersburg State Technical University**

The Department of Computer Science & Information Technology of SPbSTU has 1500 students, 50 professors, and 130 candidates of sciences (PhDs). Its Artificial Intelligence research is well-known, headed



**Professor Victor Ivannikov, Director of Institute for System Programming of the Russian Academy of Sciences (RAS)**

by Prof Gavrilova. They also specialise in multi-agents and neuroscience. ISDN line is provided 24 hours, with gateways through Helsinki. Products have been developed with Motorola, HP, Microsoft, IBM, Philips, Intel & GE. 'He who pays (in full) owns the IPR' says Prof Korablev.



**Educational Centre of Ioffe Institute, St. Petersburg**

### **Ioffe Physico-Technical Institute**

The Ioffe Institute is one of Russia's largest institutions for research in physics and technology with a wide variety of operating projects. It was founded in 1918 and run for several decades by Abram F. Ioffe. The Institute bears the name of this outstanding scholar and organizer.

The 2000 Nobel Prize for Physics was awarded to Zhores Alferov, the current director of the Ioffe Institute, jointly with Herbert Kroemer (USA) "for developing semiconductor heterostructures used in high-speed- and opto-electronics"

Dr Abgar L. Orbeli (Deputy Director), and Dr M.P. Petrov (Laboratory of Quantum Electronics) presented this world-famous Institute. The Mission saw the work being done in the field of plasma semi-conductors and hetero-structures – all quantitative work in the field of engineering and all its decisions, with much critical data capture & re-use – but no sign of cost engineering.



**The famous Russian academician Oleg Larichev and Pro-Vice Chancellor of Taganorog Radiotechnical University Professor Victor Kureichik at British Embassy in Moscow**

### **St Petersburg Aerospace Devices University**

The Mission visited the Department of Management, St. Petersburg State University of Aerospace Instrumentation. This University was founded in 1941, and since that time it has become one of the leading engineering education institutions in Russia.

The University has over 40 college and professional education programs in the fields of computer engineering, information systems and technologies, management, instrument making, radio engineering, communication, economics, law and over 30 programs of postgraduate education for candidates and doctors of science. The teaching and research of the university have

gained recognition in a wide range of areas, including: aerodynamics; radar systems; safety of moving objects; ecological monitoring; systems for collecting, processing, storing and transmitting information; computer simulation of complex physical, social and economic processes; the construction of miniature flying vehicles and their safe navigation.

### **Companies visited**

#### **Elbrus**

Elbrus Group (MCST) has provided the visa invitation for the Mission, hosted a visit in Moscow, and gave an introduction to Moscow State University (MSU). It has 600 employees and is managed by father and son team Boris Babayan (founder and CTO) and Evgeny Babayan (CEO). The main activity of the company is microprocessor



**Meeting at Elbrus Company**

chip design. This activity started in the late 50's and led to the development of the first super computer. There were several other versions of the chip named after the company. Elbrus 3 was developed in 1991, reportedly was twice as powerful as Cray. The company started collaboration with Sun Microsystems in 1991, and since 1995 has worked on an outsourcing basis with them. Elbrus also has a strong activity in

- Compiler design area,
- Operating system design and testing,
- Developing software library programmes for DSP (Mpeg, Jpeg)
- Java programming



**Decision Engineering Mission Team at Elbrus Company with professor Babayan and staff**

The company has a strong technical team with outstanding reputation and academic background, a workforce skilled in computer design, system and application software. Elbrus has the capability to draw upon extra resources through its connection with Moscow State University. The company has a good potential to grow if domestic demand (government orders) and international collaborations (Sub-contracting, technology licensing) continues. The companies competitive positioning is moderate cost and high level of skill.

Elbrus has worked with Western clients: Avanti (to Synopsis) in chip libraries, and Infineon, in the design of Application Specific Integrated Circuit (ASIC) chips.

The company has had considerable experience in chip design; low level software projects such as compiler and operating system development and therefore it can provide valuable knowledge in formalising the processes involved and development of estimation systems for cost and duration of such projects.

### **Tupolev Air Scientific and Technical Complex (Tupolev ANTK)**

Tupolev Air Scientific and Technical Complex and Ulyanovsk "Aviastar" air-factory were consolidated in a uniform structure according to the Government of Russia decree of 30 July 1999, on the basis of the two enterprises there will be formed OAO "Tupolev", to which permanent and other assets of the enterprises were transmitted. ANTK worked with Boeing and NASA to design a supersonic passenger jet on the basis of Tu-144LL and with "Airbus Industrie" to develop a high capacity European aircraft A380.

Valery I. Solozobov, Head of Engineering, presented Tupolev the aircraft design and manufacturing company. Tupolev co-operates with Sirocco Aerospace International, Air Cairo, Aerospatiale and Rolls Royce.



**Tupolev TU-204 Aircraft. © Sirocco Aerospace International Russia**

Problems in international markets have resulted in low sales and production volumes (twos and threes rather than hundreds). Nevertheless, Tupolev is proud of the decision engineering which has helped to build its reputation for quality and efficient airframes Worldwide. Tupolev company adopted integrated design & manufacturing throughout its operations.

### **Aviation Euro-Russian Consortium (AERC)**

Major Russian aviation enterprises in 1997 formed their own consortium to negotiate deals for major chunks of the A380 production program.



**Tupolev TU-204 and Tupolev Tu-334. © Sirocco Aerospace International Russia**

The consortium, known as the Aviation Euro-Russian Consortium unites the Economic Development and Trade Ministry, the Aviastar, Hydromash and Tupolev design and production enterprises, as well as the NIAT and TsAGI research institutes from Russian side and BAE Systems and AIRBUS from Western side.

It was of interest that Airbus, in working with the consortium, had urged the Russian companies to acquire costing capability as a means of understanding their business better and to be able to produce realistic quotations for work when bidding in Western markets. Part of this approach is to better understand the threat posed by high Russian taxes and to quantify their effect in export programmes.





**Aviastar manufacturing facility at Ulyanovsk on the Volga Region of Russia is one of the newest and best equipped aircraft manufacturing facilities in the world. © Sirocco Aerospace International Russia**



**LUXOFT Company. Main clients**

Rolls Royce presented its approach to Value Improvement to the AERC which included an overview of the current and future strategy for Cost Engineering. This was enthusiastically received in light of the comments made by Airbus. The capabilities that exist in Rolls Royce today could assist them significantly in this area.

Mr Galperin, Chairman of AERC & Chief of Development, Sibirsky Aluminium Group presented the group as a model of Russia/Europe aviation co-operation with 4 years of working with Airbus. A new Russia/European Research Centre agreement had been signed that day, signifying further integration with World industry.

### LUXOFT

LUXOFT is a member of the Russian IT group IBS (<http://www.ibs-company.com>) which employs over 2,000 specialists. LUXOFT was founded as a separate entity in April 2000. For five years before that the company was known as a Software Development Division of IBS that took part in complex software projects for leading Russian enterprises such as LUKoil, GAZPROM, Ministry of Railways, Saving Bank of Russian Federation, and many others. LUXOFT is targeting its services to the leading international companies, and is opening local support and development offices in the United States and Europe. The company is also expanding its regional development units in Russia with the aim of optimising scalability. Its working model is based on building long term relationship with its clients and off-shore software development. The company claims this model delivers 60% saving (\$40,000 annual average cost of each developer) compared to software development companies in the west.

With 300 IT professionals in Moscow, Omsk & Saratov, and a turnover \$6.3M it is among Russia's largest. Its developers have a price advantage in Western markets - average cost for Western developer \$100K, for a Russian in Russia \$40K. But quality is

also a differentiator. LUXOFT hires just 40 out of 300 candidates after a series of 6 interviews. Staff turnover is just 1.2%.

Eugene Peskin, Executive Vice President IBS, presented the Russian IT market turnover for 2001 as \$3.4B (1.2% of GDP). IT services are less than 30% of this (IBS \$200M in 2001, of which \$76M services). The Kremlin-driven Electronic Russia initiative aims to grow this share of GDP, and in particular the software element – “single information environment” – with the participation of the Russian Academy of Sciences.

### EPAM (Effective Projects America)

EPAM was established in 1992 by Arkady Notkin. It sprang out of the Minsk Space Research Institute. Arkady Notkin is now based in Princeton, the EPAM HQ with 20 staff. Igor Kulgan, General Director, Russian Operations & Leonid Lozner, Technical Director (one of the 3 founders) presented the company.



**Mission Team at EPAM Company, Moscow**

There are 80 staff in Moscow and 250 in Minsk (the development centre). Turnover \$10M based on ‘Moscow development’ revenues. Their niche is content & knowledge management – more decision engineering in all but name. Collaboration is with Numerix, SAP, PTC (Parameter Tech. Corp. a CAD company in Boston, Mass).

EPAM provides software development, e-commerce and content services. EPAM is a privately held Limited Liability Corporation founded in 1993. While a wholly owned US entity, headquartered in Princeton, NJ, EPAM is operationally structured as an onshore/offshore operation. EPAM is the

largest provider of technology outsourcing and e-commerce solutions in the former Soviet Union region.

EPAM Data Warehousing technology offers a number of capabilities to potential clients in the areas of Data Acquisition, Data Modelling, Data Mapping, Meta Data, Data Management, Data Mining and OLAP and Data Warehouse Management and Support.

EPAM also has developed

- An integrated CRM/Business Intelligence framework,
- Data Warehouse Design
- Data Cleaning
- Integration with ERP, Front-end and External Data Sources
- Customised Solutions using leading data warehousing tools

According to EPAM, it has implemented a number of large-scale Data Warehousing projects for clients like Bally of Switzerland.

### Fort Ross - St Petersburg

This is an umbrella marketing company for high-tech start-ups, mostly in out-sourcing, and mostly in decision engineering fields. Fort-Ross is the organiser of an Outsourcing Summit in St Petersburg 5-6th June, 2002. The previous Fort-Ross President, Valentin Makarov, has gone on to be the chief of Russoft (all-Russia software association).

### Digital Design

Digital Design Russia is a software development company established in St. Petersburg, Russia in 1992. It was originally formed as a start-up company by a group of computer software enthusiasts. Today, Digital Design Russia employs over 120 people.

This is one of the Fort-Ross companies, and it is in Information Systems Development.

It has offices in London and Philadelphia, and in St Petersburg. Turnover is \$3M – 50% with Russian Railways. It has joint-ventures with Deverill plc., IBM, Microsoft, and CISCO.

Digital Design Russia launched its first big contract with a major Russian railway company in early 1993. Digital Design Russia's core business is custom software development. The company develops software projects for its clients as an outsourcing partner. Major areas of the expertise are as follows:

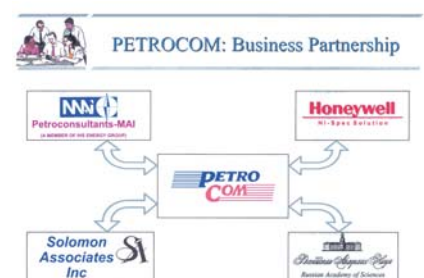
- Application Integration
- Data Warehousing and Decision Support Systems
- Electronic Document Management
- Workflow
- Internet/Intranet and
- E-Commerce Solutions

### Star SPB Ltd. - Member of Fort-Ross

STAR SPB is the Russian subsidiary of STAR AG, Switzerland. The company was founded in St. Petersburg in 1991 on the basis of the Laboratory for Computational Linguistics of the Institute of Linguistics (Russian Academy of Sciences) and became affiliated with STAR AG in 1995. Today STAR SPB has 150 fulltime employees and a primary focus on Intelligent Systems, offshore software development and R&D activity in language engineering and technical translation. The STAR Group has a permanent staff of more than 1,000 employees in its 26 offices world-wide.

### Petrocom Joint-Venture

Professor Leonid R. Sorkin, Chairman of the Board, presented the work of Petrocom Company.



**Petrocom Company  
Business and Educational Links**



**The Mission Team at Digital Design Company**

Petrocom is the leading company of oil and gas Information and Decision Support Solutions. As such Petrocom is an affiliate of Sibintech, the second-largest software outsourcing company in Russia. Petrocom reckons to be an advocate of decision engineering, and Professor Sorkin was a recent winner of the Russian Academy of Sciences prize for best managers in their field. With Professor Sorkin were Dr Alexander Karibskiy, Head of Dept of Financial & Economic Analysis & Investment Studies, and Dr Victor M. Dozortsev, Head of Dept of Computer-Based Training & Industrial Safety Systems, both disciplines are reliant on knowledge analysis and re-use.

Bee Pitron is leading provider of advanced integrated EDM/PDM and CAD/CAM/CAE solutions for automotive, aircraft, shipbuilding and other branches of industry in CIS.

Formed in 1992 by Dr and Mrs Leonid Zilberbourg from the reseller for Cimatron, the Israeli supplier of tooling & instrumentation (CAD) systems, who is still a major shareholder, this company has 59 people in St Petersburg, and 30 in offices in the Urals, Volga, Siberia & Ukraine. The business objective is to introduce Western technology (Cimatron ARC CAD system) into Russian industry (VARs, integration, re-engineering).



**The Mission Team members at St. Petersburg Regional Foundation for Scientific & Technological Development**

### **Regional Foundation for Scientific and Technological Development**

This is an 'incubator' for small enterprises, established with regional funding and encouragement from the Leningrad Oblast. It is housed in a former electrical foundry in the industrial area of St Petersburg. The CEO, Igor V. Gladkikh, presented several of his nascent companies, including an outsourcing company Infolink, which is in fact well-established with offices also in London & Horsham in the UK.

### **Bee Pitron**

For more than ten years, Bee Pitron has been being supplier of advanced engineering technologies in CIS.



**Bee Pitron Company, St. Petersburg Main Building**

# Opportunities for British Companies

## Opportunities for British Companies

Mission members have mentioned that given the nature of decision engineering and a good sample of companies visited, the mission achieved its objectives. More specifically several companies are developing data analysis and information management technologies which are important enabling technologies for e-businesses.

Dr Ben Azvine, BTextact, said: 'From a scientific point of view my interest is in soft computing and computational intelligence and there wasn't enough evidence regarding the status of these technologies either in academia or in industry. My belief is that there are institutions who are performing research in these technologies and that the broad nature of the mission didn't allow for discussions with visited institutions on these matters. However such detailed discussions are possible following the mission with the relevant institutions through joint conferences and workshops.'

Given the relative youth of the Russian IT industry there are several opportunities to co-operate with some of the companies named above to do joint product development for the Russian market. Mission members intend to continue discussions with Russian companies about market opportunities in Russia. There are also collaborative opportunities to use Russian IT companies to develop products based on western technology taking advantage of their design capability and relative cost benefits.

Russian companies willing to invest in high technology prefer to buy from abroad. This represents an opportunity for western organisations to provide advanced technology and win a share of the Russian market. There seem to be strong ties with some western government such as Germany and Scandinavian countries.



**Red Square**

General view is that there is a significant opportunity to develop decision engineering with Russian companies and universities in the medium to long term. In the short term however the focus should remain on building the IT infrastructure of the Russian industry.



**Neva River, St. Petersburg**

Intelligent decision making technologies will be an added layer requiring such an infrastructure for collection, analysis and presentation of results needed for decision engineering. Given the wealth of talent and capability available within Russia and the relative lead that Britain has in this area relative to other European countries we are well placed to exploit this opportunity through closer academic collaboration, sponsored exchange programmes for UK and Russian industrialists, and joint conferences and meetings specifically to promote closed scientific and industrial co-operation between the two countries.

The most relevant aspect to Rolls Royce was the time spent with representatives from the Aviation Euro-Russian Consortium. The practices required are currently deployed to suppliers in its supply chain and would require little in the way of modification to meet the need. Clearly there would be need to be of mutual benefit in order to justify the cost and effort of technology transfer. This could possibly come from collaboration at a supply chain level as part of an emerging market supplier development strategy.

Other opportunities generally fall into two categories - opportunities for future business and opportunities for carrying out research.

In terms of business opportunities there were a number of suppliers visited involved in the production of components which may

provide potential avenues for emerging market supply. Contacts will be made with the relevant authorities within Rolls Royce to assess interest for follow-up action. The DTI have offered assistance to any follow-up action which might be key, especially where translation is required. Opportunities include machining of curvilinear surface geometry, composite materials, electrical harnesses, supply chain documentation distribution software (a Boeing application), virtual reality engine servicing and build manuals (also a Boeing application) and CADDS integration tools.

Corus Rail is only just beginning to exploit Decision Engineering techniques to provide solutions to the UK railway industry. As a team with relatively scarce resources, they would be most likely to explore their links with Cranfield University in the field of Decision Engineering rather than interacting directly with organisations in Russia. However, they would like to encourage Cranfield University to use the obvious talent available in Russia as this can only strengthen Cranfield's position as a leader in the field of Decision Engineering research.

# The way forward



**The Main Building of the Russian Academy of Sciences**

The mission team was impressed, as they might have expected, by Russia's theoretical research and scientific skills; it is advanced in some supporting technologies for decision engineering such as advanced data management and optimisation software and techniques for decision-making using neural networks, fuzzy logic and genetic algorithms. Equally impressive, though perhaps less predictably so, were the very strong links between universities and industry which ensure that the former know what the latter needs. As an example, the long-term relationship between Bauman Moscow State Technical University and GAZPROM Bank. This bank provides services to GAZPROM - the world's biggest gas company which accounts for 94 per cent of Russia's gas production. Bauman is very good in the implementation of IT services and training in the banking industry.

In terms of research a number of operating models appear possible using various combinations of Russian research and IT. The key advantages being the pedigree in academic research available with respect to applied mathematical simulation techniques which play an important part in Cost Engineering tools and methods. In addition the use of IT software integrators is also a possibility in being able to take advantage of low cost labour rates yet with suppliers who are accredited to Western standards and have UK based offices. Some were also familiar with business and research methodology integration, delivery and management of international blue chip client projects and have linked information systems to CADDS tools previously - an integral part in best practice Design to Cost methodology.

In summary, there is a massive amount of potential within Russian universities and institutes with a good mix of theoretical and applied research. The term 'decision engineering' is new to most Russian academics and industry but there are many examples of research into Decision Engineering techniques and applications. It is clear, however, that state funding is scarce and there is increasing competition

between organisations for this support. Hence, there is a drive to create partnerships with commercial organisations (both Russian and foreign) that are prepared to provide financial support for research programmes in return for ownership of the intellectual property rights of new ideas generated by the research.

For Rolls Royce the Mission was a success in allowing the dissemination of their own developments in value improvement practices to be communicated more widely and in so doing assess their robustness against a more diverse business model. In addition it provided a benchmarking opportunity in the field of Cost Engineering and therefore a means for the continuous improvement of strategy and methods.

An important part of the programme was to evaluate equivalent developments in Cost Engineering methods of Russian academies and industry. In summary the lack of demand for these techniques had not stimulated a need to develop them. Part of the task is to understand why and to recognise the opportunities presented in closing the gaps if they are to realise the benefits. Advancements in fundamental research programmes complimented with its integration by one of its prestige IT companies presents a realistic alternative in looking at future strategy and methods development. Specifically with respect to Design to Cost where there is a real need for articulate decision making solutions combined with their integration at the business interface.

Overall it would appear that the utilisation of Russia as an emerging market is slow. With much of the capability and capacity in more established low economy markets being taken up by Japanese and US exports, Russia might have to be developed as viable competition. It would appear that fundamental capability is in evidence but requires investment and development to meet the requirements of Western markets. The opportunities are, however, real and provide a capable alternative to the current established low cost economies.



**The Mission Team with Commercial  
Counsellor of British Embassy in Moscow  
Mr Simon Smith**

However, there was encouraging signs, particularly from the IT sector and the Aerospace institute of a willingness to learn. There is an opportunity to transfer skills and undertake training on a large scale. In our opinion, the academic institutes would welcome the opportunity to include Cost Engineering as part of their curriculum for their engineering courses. Russian Aerospace organisations were very enthusiastic to attain the skills of the Cost Engineer as they recognise that to compete in this global economy will require making some tough economic decisions that require a level of technical expertise. The ability to conduct investment appraisals is essential in order to reach the right decision that is well founded.

The IT sector, being more commercially aware was also keen to attain skills in software cost estimating. Traditionally an area of high risk, the ability to produce robust cost estimates for software intensive projects is perhaps the most difficult task of the Cost Engineer to get right. The Association of Cost Engineers have an opportunity to expand membership and Mr Nigel Buttrick, ACostE representative is recommending that they consider a marketing opportunity to capture a willing enthusiastic huge market which has gone relatively unnoticed to date.

In the meantime, a number of e-mail mail shots will be dispatched recommending that engineers interesting in knowing more about the role of the cost engineer visit the ACostE website and consider joining the association.

IT sector is also benefiting from the success of companies such as LUXOFT, the main developer of IT tools for oil and gas, banking and aerospace industry. LUXOFT has international certification in software development and is now a major organisation involved in complex international projects for clients such as Boeing, Citibank and IBM.

According to International Technology Promoter Dr Juan Matthews one of the mission's most interesting findings was the way a group of smaller Russian companies,

supplying the major aviation players, is facing up to the requirements of their industry and driving decision engineering progress.

'These companies requested help from the representative of the UK's Association of Cost Engineers on the mission team in establishing cost engineering as a discipline in Russia. As a direct result, a proposal will be made to form a UK-Russia Centre for Decision Engineering at our dissemination event. There are also opportunities for UK companies to start introducing some of our best practice into Russia to help its industries become more competitive' [Juan Matthews].

A dissemination workshop is planned for the 28th of July 2002 at Cranfield University as a part of the CE2002 Conference. With support from DTI, Cranfield is also developing a 'Virtual Discussion Forum' on the web to promote technical communication between the British and Russian Industries. A 'Virtual Discussion' event is also planned for November 2002.

This clearly has to be balanced with issues of communication and interpretation, time difference, logistics and cost of travel, cultural differences and the overall need to work closely on such projects when particularly treading new ground. The first step has, however, already been taken.

## Appendices

### Contact details

Elbrus  
14, B.Savvinski per., Moscow, 119435,  
Russia  
<http://www.elbrus.ru>

Moscow State University  
Vorobjovy Gory  
Moscow, 119899, Russia  
<http://www.msu.ru>

Bauman Moscow State Technical University  
Address: 107005 Moscow, 2nd  
Baumanskaya Str., 5 Russia  
Tel: +7-095-263-6391  
Fax: +7-095-267-9893  
<http://www.bmstu.ru>

Tupolev Air Scientific and Technical Complex  
(Tupolev ANTK)  
17 Tupolev Embankment,  
111250 Moscow, Russia  
Tel: + 7-095-267-2508,  
Fax: + 7-095-261-0868, 261-7141

Aviation Euro-Russian Consortium (AERC)  
Petrovka Str. 24  
Moscow, Russia  
Tel: +7-095-311-07-41

LUXOFT  
9-b Dmitrovskoye shosse  
Moscow 127434, Russia  
Tel: 7-095-967-8030  
Fax: 7-095-967-8034  
<http://www.luxoft.com>

Institute for Systems Programming  
109004, Moscow, B. Kommunisticheskaya, 25,  
Russia  
Tel: +7-095-912-44-25  
Fax: +7-095-912-15-24  
<http://www.ispras.ru>

Petrocom  
117997, Moscow, GSP-7, Profsouznaya Str.,  
65, Russia  
Tel: 007-095-334-87-71, 334-90-41  
Fax: 007-095-420-2016  
<http://www.petrocom-jv.ru>

EPAM Systems  
1/19 Kuznetskiy Most, Moscow, Russia  
103031  
Tel: +7-095-925-5341, 921-2611  
Fax: +7-095-921-4776  
<http://www.epam.com>

Ioffe Institute  
26 Polytekhnicheskaya, St. Petersburg  
194021, Russia  
Tel: +7-812-247-2245  
Fax: +7-812-247-1017  
<http://www.ioffe.rssi.ru>

St. Petersburg Foundation for Regional  
Development  
St.Petersburg, 194156  
P.O.B. 33, Russia  
Tel: +7 -812-244-2511  
Fax: +7-812-326-6191  
<http://www.rfntr.neva.ru>

St.Petersburg State Technical University  
195251, Saint Petersburg,  
Polytechnicheskaya, 29.  
<http://www.spbstu.ru>

Bee Pitron Ltd.  
Vilenskiy pereulok, 4  
St.-Petersburg  
191014, Russia  
Tel.: +7-812-272-1666, 273-3004  
Fax: +7-812-272-3869  
<http://www.bee-pitron.com>

St. Petersburg Aerospace Devices University  
Bolshaia Morskaya Str, 67  
St.Petersburg, Russia  
<http://www.aanet.ru>

Fort-Ross  
Office 5, 7 Pirogova lane,  
St.Petersburg, 190000,  
Russia  
Phone: +7-812-314-4336  
Fax: +7-812-315-4347  
<http://www.fort-ross.ru>

STAR SPB Ltd.  
Tambovskaya 12  
192007 St.Petersburg  
Russia  
<http://www.star.spb.ru>

Digital Design  
Odoevskogo 28 P.O. Box 622  
Saint-Petersburg, 199155  
Tel: +7 -812-346-5833  
Fax: +7-812-346-5834  
<http://www.digdes.ru>

### **Web-based information resources**

**<http://www.cranfield.ac.uk>**

Cranfield University. One of Western Europe's largest academic centres for strategic and applied research, development and design

**<http://www.dti.gov.uk>**

UK Department of Trade and Industry

**<http://www.globalwatchonline.com>**

The website of DTI's International Technology Service

**<http://www.globalwatchonline.com/itp/>**

International Technology Promoters Programme

**<http://www.britishscience.ru>**

Joint web-site of the British Council and British Embassy Science Teams in Moscow

**<http://www.istc.ru>**

International Science and Technology Centre, Moscow

---

### **Rajkumar Roy, Victor Taratoukhine**

**Decision Engineering: Informed Operational and Business decision making within Industry.**

The findings from a high technology mission to Russia

Available from:  
Department of Enterprise Integration  
Cranfield University  
Cranfield, Bedfordshire  
MK43 0AL

Tel: +44 (0) 1234 754073  
Fax: +44 (0) 1234 750852

Rajkumar Roy, Victor Taratoukhine

# **Decision Engineering: Informed Operational and Business Decision Making within Industry**

The findings from a high technology mission to Russia

