Dr Brian Shaw
Reader in Business
Oxford Brookes University
School of Business
Wheatley
Oxford OX33 1HX

Tel: 01865 485945
Fax: 01865 485830

PCFC and DEV R Funding
ABSTRACT

The context, pre-August 1991, was a centrally administered innovation system with the dominance of the military in resource allocation in a "shortage" economy.

The network was made up of the ministry of defence, design bureaux, manufacturing plants, research institutes, specialist universities and testing centres and the Aircraft Certification Authority.

Post-Perestroika the need for new customers, international certification, western collaboration, and the presence of supply chain disruption and the funding crisis are reshaping the network.
INTRODUCTION

The context within which this network operated before August 1991 was one of a Soviet Union whose research, development and innovation (RDI) systems had the longest history of any centrally dominated national innovation system, some 50 years (Hanson & Pavitt 1987). In addition the impact of the German advance on Moscow determined the re-location to and concentration of aircraft manufacture in Kuybishev now (Samara), a closed city until 1992. The 'cold war' determined the dominance of military demands in the economic planning resulting in an imbalance in resource allocation within an economy already suffering from what (Berliner 1988) called a "shortage syndrome". The civil aviation sector of the industry was treated as part of the military demands in that the aircraft were designed and built alongside the military planes and all Soviet Union airspace was controlled by the military.

The generous budget given to the military by the Department of Military Industry of the Central Committee of the Communist Party ensured the funding of a complex and sophisticated networking system made up of design bureaux, manufacturing plants, academies and research institutes, specialist universities, the Aircraft Certification Authority and specialist testing centres such as Central Aerohydro Dynamic Institute and the Flight Test Centre.

Post-Perestroika the need for new customers, the international certification of aircraft, the introduction of new technologies, collaboration with Western aircraft and component manufacturers and the presence of disruption of the Russian supply chains, coupled with the funding crisis in Russia are resulting in significant changes in the nature and relationship between the activities, resources and actors in the network.
RESEARCH METHODOLOGY

The methodology was in-depth interviewing, with senior politicians, academics, directors and managers. The sample included such interviewees as the Chairman of the Committee on Education and Science, Supreme Soviet of the Russian Federation, Chief Designers of Design Bureaux, General Directors of Aircraft, Engine and Rocket Plants, Vice-Rectors and Chairs of Departments of Universities. In total 37 people were interviewed, of whom 2 were Government Ministers, 14 were Senior Academics, 10 Design Bureaux Heads/Chief Designers and 11 Plant Directors/Senior Managers, with 9 being interviewed twice, once in April and July 1993 and again in April and November 1994. These interviews were carried out with personnel in the White House in Moscow, in ex KGB buildings and in plants and design bureaux which previous to August 1991 were impenetrable. In fact, the majority of the interviews were carried out in Samara (the previously forbidden city of Kuilbyshev, the centre of Russian aircraft manufacture. The interesting mix of the key actors in and the authorities on the networking system enabled a balanced view of the way that the system worked to be gained.

LITERATURE REVIEW

The network of the industry was pre-1991 part of the Soviet research, development and innovation (RDI) system which itself was set within a centrally administered economic system [Hanson and Pavitt 1987]. This economic system, according to Kornai 1980, created shortages in the Soviet economy. The source of this shortage was "the soft budget constraint" (SBC) which was the commitment of the leadership to maintain production in all enterprises regardless of their efficiency. Knowing that they would always be bailed out by the authorities, enterprises were not firmly
constrained by financial budgets to limit the quantities of current and capital resources that they sought to obtain. These SBC's acted as an enormous suction pump drawing resources and products into warehouses and production lines of enterprise as soon as they were available for delivery. "(Hanson and Pavitt 1987)" suggested that the firm with the SBC lacked the need for imitative or defensive innovation to stay in business against innovatory competitors and "(Schumpeter's 1943)" gale of creative destruction would not be allowed to blow anything over. In fact SBC enterprises tended to build up 'hidden reserves', the hoarding of inputs and the use of the plan bargaining with hierarchical superiors to obtain the least targets. As the firm's behaviour was directed primarily to plan fulfilment rather than to customers or suppliers, the preferred innovation would be ones that make little or no extra demand on producer's own resources or materials allocations, while adding to revenue and bonuses through favourable pricing, centrally set. "(Holzman 1955)" and "(Hunter 1961) suggested the cause of the shortage was the focus of the Russian manager's concern for the monthly output plan target, which was generally perceived as "unrealistic" or "excessively taut", especially when overfulfilled current plan targets became future targets, thus creating the "ratchet principle" "(Berliner 1957)". The tautness assured that a certain proportion of all plans were not fulfilled. In a tautly planned economy, underfulfilment of the plan by an enterprise was experienced as a shortage by the enterprise that was to have received the output. Shortage thus percolated through the inter-industry relationships of the system.

In additional to this shortage of supplies, as "(Clarke et al 1994)" identified, was the problem of the enterprise management to compel or persuade the workers to produce the goods demanded of the enterprise by the centre. This research suggested that the Soviet workers appear to have been powerful, in that managers made extensive concessions to enlist the workers cooperation. These concessions were made strictly
on an individual and discretionary basis, not as the expression of workers’ power (not as the expression of a ‘social contract’), but as an expression of an ‘authoritarian paternalist’ hierarchy. These concessions included the network of special and welfare benefits supplied by the enterprises which provided a system of discretionary incentives administered by the managers and trade union. They suggested from their case study analysis, that there are enormous barriers that confront any attempt to transform the internal production and management relations of Soviet enterprises, a superficial reform of management structures and managerial ideology is relatively easy to achieve, but any attempt to transform working and productive practices unleashes potentially serious conflict within the labour force, within the structure of management and between managers and workers.

As a consequence of this "shortage syndrome", the daily practices of quality deterioration, hoarding, barter and resale, supply expedite, gifts and bribery, organisation ‘autarky’ and priority awareness persisted. Priorities were not only important in the firms’ relations with the state, but also in their relations to other firms. Firms discriminated amongst one another according to the relative priorities of competing buyers. In practice this meant that there was a tendency for firms to fill the orders of military customers ahead of heavy industry customers and of the latter ahead of light industry customers "(Berliner 1988)". "(Weiss 1993a)" suggested that, despite its emphasis on investment in science and technology, the communist system of physical and economic planning created such a shortage economy.

"(Weiss 1993b)" stated that Russia was in the first stage of his model of the stages of scientific and technological development for a competitive market economy. By the end of this stage, there were many enclaves in both the government and productive sector of capacity to choose, operate and manage modern technology. However, at
this stage, the inter-institutional linkages critical to the functioning of a modern technologically sophisticated economy have, for the most part, not emerged for want of demand for improved technology in industry generally. The absence of these linkages created isolated "enclaves of competence in a congealed system", focused on collecting "economic rents" derived from political connection and superior understanding of the workings of the regulatory system. There was a heavy reliance on the close knit "old boy network" and practice of "blat" (bribery) which it spawned "(Berliner 1988)". The output of the military technology in the defence enclave is reflected in Russia with the early advances in space technology, as illustrated by the ICBM's studies of "(Amann, Cooper and Davies 1977)".

For strategic reasons the defence enclave strived for self-sufficiency in the development of military technologies and at the end of the 1980s it received some 20% of the annual defence budget and 70% of the science funding. At the beginning of 1992, under the control of Russian's military-industrial commission 700 large R & D organisations, employing 1.3 million people, were still in operation. However, between 1989 and 1992 the volume of military R & D was reduced by a third and state budget funding for research in 1991-1993 by nearly 70%. In addition the financing sources outside the defence budget had dried up. "(OECD 1993)"

The overall innovative system was linked to the development programmes of the military technologies with R & D for civil needs also being carried out in the research institutes of the military-industrial complex ie 30% of their total R & D funding in 1988. "(OECD 1993)" This activity was related to civil production in defence companies with the civil products being designed according to military parameters which ensured the possibility of fast conversion to military production if so required. In fact these research institutes were responsible for nearly all of the development of
high technology in the civil sector and for the paramilitary "dual-use" technologies. 
"(Nironen 1994)"

It follows from Kornai's analysis that if Russian leadership wishes to eliminate 
shortage and its consequences, it must find a way of building "hard budget 
constraints" (HBC's) into enterprise decision making. However, neither reduced 
tautness nor a HBC are practical policies for eliminating shortages as long as the 
economic mechanism continues to be based on mandatory quantitative output targets 
(the 'assortment plan') and centralised distribution of intermediate products (material-technical supply), the two planning methods at the core of the central economic 
planning system "(Berliner 1988)". However, these two planning methods are now 
starting to be undermined by the market place and, as a consequence there is a long 
term potential for a reduction in tautness and SBC's in the Russian economy. 
Meanwhile, the chaos being created by the necessary restructuring of the economy 
has had a significant impact on the workings of the aerospace network and its future.

THE NETWORK

AIRCRAFT DESIGN BUREAUX

The network is illustrated in Figure 1 with the focal actor in the network prior to 1994 
being the Aircraft Design Bureaux.

The aircraft design bureaux were guaranteed monopoly sales and payments for the 
aircraft that they designed. During World War II, 44,000 Russian fighter aircraft, the 
IL2, were manufactured. In the civil aviation field between 1967 and 1990, the 
TU134, IL62, IL86, YAK 40 and 42, AN24 and TU154 had no competition and were
the carriers for all USSR and CMEA countries with the 1,000th TU154 passenger airline being built in 1994. "(Tyuchtin 1993)."

The Chief Designer of the Bureaux had his lobby in the Ministry-Industrial Commission, which existed within the Council of Ministers of the Soviet Union. More important was the Department of Military Industry of the Central Committee of the Communist Party, as they managed the annual budget for the bureaux. The regional communist committees were also powerful and, in particular, the Samara region due to its concentration of aircraft manufacture. This concentration was due to the German advance on Moscow resulting in aircraft manufacture being moved from Moscow to Samara (the previously forbidden city of Kuibyshev). However, the Central Committee sought advice from the Politburo where guidelines were developed. It was, therefore, necessary also to lobby the Politburo, especially as it recruited personnel from the other regions and different branches of industry whose support was needed. This previous lobby system was reasonably stable and once the decision to support a particular aircraft design was made, state funding was decreed and material supplies assured. As a result of the stability of this system the Design Bureaux have long histories with for instance Tupolev celebrating its 72nd birthday, Ilyushin its 62nd and Beriev its 61st in 1995. They were also the focal actors in this network as controllers of the budget given to them by the government for the aircraft they had been contracted to design and develop. They were responsible for all the stages in the innovation process illustrated in Figure 2 ie the design, testing, certification, launch, marketing and continuous development of all aspects of the aircraft over its lifecycle, coupled with oversight of the production so as to ensure that the safety criteria demanded in the certification are met. There are seven main bureaux responsible for the design of civil aircraft: Antonov in the Ukraine, Beriev in Taganrog, Russia, and Ilyushin, Tupolev and Yakolev, plus the helicopter bureaux, Kamov and Mil, all in
These Bureaux were significant organisations, employing for instance, just in the 
design department of the Ilyushin Bureau, some 2,200 people. "(Katyrev 1993)"
Within the design department was the design group with its heads of discipline and 
below them, the departmental design heads for wing, fuselage, take-off and landing 
gear, power installations, the general equipment departments, such as electric, hydro-
pneumatics, navigation, control systems and reserve support systems, special 
equipment departments, such as viewing and targeting and payload and fuel 
departments. The norm in these departments was to have ten teams each having 12-
14 scientists/engineers. "(Samoylovlch 1993)" In addition to the design department 
Ilyushin's other departments include experimental manufacturing facility, flight test 
centre, industrial and vendors' equipment, maintenance department and customer 
support for its aircraft. With the introduction by Ilyushin of mathematical modelling 
in Stage 2 and 3 of the innovation process the initial hierarchical structure, where 
each department had links with other departments through the roots, was 
transformed into a net structure with all of the departmental data being fed into the 
Numerical Structural Analysis Department whose Chief now has all the departmental 
heads reporting to him. "(Zarubin 1993)"

The potential incompatibility of the design of the various elements was therefore 
overcome in the Ilyushin Bureau through the creation of Model II (Figure 3) which 
includes every detail of each element integrated in time and space in one model. 
These elements (rods, beams, plates, etc) are used as a language for design, enabling 
the finite element model to be produced before the drawings are made (see Figure 4). 
Model II includes models of layout, geometrical aerodynamic shaping, aerodynamics, 
inertial elasticity and thermodynamics to achieve the design object. It is possible to
create the whole structure of the aircraft as one elastic system. The totality of the elastic model makes it possible to calculate precisely aircraft loads, analyse structural sensitivity, optimise the structure (minimise structural mass) with stress, displacement, frequency, critical velocities and many other constraints. "(Komarov 1993)"

EXPERIMENTAL PLANTS

These plants are part of the aircraft design bureaux and carry out natural tests on a minimum of 4 test planes for civil aircraft and 12 for military aircraft.

To assist the experimental plant the first prototype is sent to the Flight Test Institute, which tests all Russian aircraft and, therefore, has 'priceless experience'. "(Koptev 1993)" The test aircraft are flown by the Bureaux test pilots, who carry out the test plan that has been devised by the Chief Designer in collaboration with the Head of the Test Institute. The aircraft are also sent to Russia's Central Aero Hydrodynamic Institute (TsAGI) for instance, the Tupolev TU334 has sent one airframe to TsAGI for static structural test. Five prototypes will be produced. The fourth will be used for ground lifetime cyclic structural tests and the fifth (actually the third flight test model) will become the pattern for future production. The evaluation at this stage was to determine if the aircraft received its Certificate of Airworthiness from the Russian Interstate Aviation Committee. However, the key issue now being faced by the civil aviation industry in Russia is certification to US Federal Aviation Rules (FAR), ie FAR 25 and 23, and the Joint Aviation Rules (JAR) of Europe, JAR 25 and 23, which, if received, will enable them to market their aircraft worldwide. Mathematical modelling has assisted the process in that it can test some elements that cannot be tested naturally and natural tests can be confirmed. The three mathematical models which
are in the Russian RIPAK system compare with the US NASTRAN model in determining aerelastic and structural definitions. "(Zarubin 1993)"

**FILIAL AIRCRAFT DESIGN BUREAUX**

These Filial design bureaux have been set up at most aircraft manufacturing plants. They advise the main Bureau on faults in the aircraft design when moving into serial production and also act on behalf of the main Bureau as the supervisor of mass production as it refers to design. In this role it acts as the 'shock absorber' in the conflicts between the demands of the main Design Bureau and the main plants. "Our role as an intermediary increases with the move of new designs to the plants. This will take some three to five years. During this time, the first aim in life is to maintain stability between the two large whales (the Design Bureau and the plant) although each of the three manufacturing plants in Samara are different and a special approach is necessary to each plant." "(Trofimov 1993)" In 1994, these Filial Bureau were instructed by the Minister to become independent joint stock companies and they have now become part of the new complexes being set up. "(Gritsenko 1994)"

**RESEARCH INSTITUTES**

The Research Institutes such as: Institute of Research into Aircraft Engine Building, Research Institute of Engine Technology and Production, Research Institute of Aviation Materials, Research Institute of Aviation Technology and Go NIIAs, the Research Institute for Avionics, Research Institute of Aviation Technology and Production, for instance, who all have continuous linkages with the industry are now also asked for their expert advice by the Russian Interstate Aviation Committee and FAA when verifying the certification claims of the design bureaux. This change in
relationship between the research institutes and the design bureaux has yet to have its full impact on their network activities. The Research Institutes used to be commissioned to carry out specific research briefs from the Ministry, the Bureaux and the Plants and in general tended to diffuse the output from the research throughout the network, especially if it was Ministry funded research. However, the Ministry sometime demanded that the results be advised to other actors especially the results from the HQ and regional branches of the Institute of Aviation Technology and Production. Now, with the fierce competition between bureaux, research institutes and aircraft and engine manufacturing plants this level of cooperation and diffusion of knowledge will probably be diminished greatly. With the majority of staff nearing retiring age the close formal and especially informal networks operating in this industry will probably diminish with the entry of new blood operating in a competitive market economy.

UNIVERSITIES

Supplying all of these organisations with trained staff are the universities, such as Moscow State University, Moscow State Technology University, Moscow Aviation Technology University, Moscow Energy Institute, Moscow Institute of Physics and Engineering and Samara State Aerospace University. Graduates were guaranteed employment with the network, the best going to the bureaux. Now there are problems with the bureaux reduced level of activity and the loss of funding of the research Institutes, the graduates are going into computing and banking, etc, where work is available. "(Balakin 1993)" The professors in the specialist aviation universities have all worked in the bureaux or plants before entering the university and have continuous research links with them. Their doctoral research is normally carried out in collaboration with the bureaux/plants and is funded by them. The present crisis
is potentially even more damaging in that the peak staff intake into the bureaux was in the mid-fifties and they are now of retiring age. The tragedy would be the loss of transfer of their knowledge and experience to the new generation of scientists and engineers and, therefore, the loss to Russian science for ever. "(Komarov 1993)" The Academies, such as the Russian Academy of Science, the International Engineering Academy and Natural Science Academy also do basic and applied research of benefit to the industry.

INTERNATIONAL CIVIL AVIATION ORGANISATION

The USSR had limited contact with ICAO with clearance of Aeroflot flights in international air space. Within the USSR the military dominated the air space and any civil needs were subjugated to the military demands. In Estonia for instance their air space was controlled from Moscow and all management and air traffic control posts were filled by Russian personnel. The Estonians were only allowed to be 20% of total staff and could not hold any of the management posts. They, therefore, presently have a major task of training Estonian staff to manage and negotiate use of this air space and aviation infrastructure. "(Sormus 1994)" Now Russian needs to negotiate routes through all ex-CEMA countries as well as other international routes and abide by the strict ICAO regulations.

WESTERN COLLABORATORS

The entrepreneurial Ilyushin bureau forecast some of the potential chaos, with the break up of the USSR, and at the end of 1990 started negotiations with a group of businessmen including Mr Hammer from USA, Mr Maxwell from the UK, Mr Reichman from Canada and a representative from the Israeli aviation industry. All of this group
eventually withdrew but US President Bush and Gorbachev carried on the negotiations and an agreement was reached that resulted in the Incorporation of Pratt and Whitney engines into the Illyushin aircraft IL96M and IL96T. Eighteen US components manufacturers subcontract to Pratt and Whitney as main contractor and each of the actors taking part in the aircraft development are sharing the risk and funding their part of the project "(Katyrev 1993)". Rockwell Collins supply the traffic alert and collision avoidance systems (TCAS) for these aircraft and also to the TU204 designed by the Tupolev Design Bureau. The TU204 also has Rolls Royce engines, Hunting Aircraft seats, Smiths Industries avionics and Litton's inertial reference system. All of these Western parts impact on the design of the aircraft and must be accommodated in the mathematical models now developed to create the IL96. All of the other bureaux are actively seeking collaboration with and/or working with Western companies.

Again, one of the major reasons for collaboration with the Western partners is to gain certification faster so that they can enter the world market, but also to lock into the worldwide maintenance and service systems of these partners. "(Katyrev 1993)" is convinced that a bilateral agreement will forthcoming in early 1996 between Russia and the USA on certification, when Russian certification will be acceptable to the Federal Aviation Administration (FAA). The FAR and Russian certification will be similar. Shadow certification was agreed in January 1992 by Sushkol, the Head of IAC, and Broderick of FAA for IL96 and IL103 aircraft. The bilateral agreement for IL96 is considerably advanced after 25 meetings with FAA and the support of Illyushin's US partners.
SUBCONTRACTORS

For all the design bureaux, the plants, the research institutes etc another great problem is the secession of the Republics from the USSR creating the "nearest abroad" mentality in negotiating for supplies which were previously obtained from the USSR monopolist supplier. The Ilyushin Bureau had 500 different suppliers. This problem is further aggravated by the nearest abroad suppliers, eg the Ukraine, trading their copper pipes, for instance, with the "furthest abroad", eg Western countries, for hard currency and then buying in roubles from Russian suppliers, but demanding dollars for their goods. "(Koptev 1993)" With the rouble becoming a harder currency, the imposition of import duties and the problems of shipping through the Ukraine and Belarus, the search for Russian suppliers is becoming urgent. "(Ermolov 1994)"

AIRCRAFT AND ENGINE MANUFACTURERS

One great problem that the manufacturing plants have is that they were designed to produce everything for the aircraft, because of the supply constraints during World War II, with the need to be a complete stand-alone manufacturing unit. This tradition still applies to some extent with 240,000 parts for AN124 and a similar number for TU204 being manufactured and stored in the Ulyanovsk plant. This increases significantly the cost of manufacture in comparison to the Western system where the just in time supplies are delivered to an assembly plant, such as those of Boeing and Airbus "(Gulyaev 1994)".

The Head Aircraft Manufacturing Plants also used to ensure full capacity through manufacturing aircraft for two or three bureaux "(Gulyaev 1994)" and by ministerial directives, sometimes resulting in an inability to manufacture the newer aircraft, eg
the AVI.S plant were not able to take on the TU204 in replacement for the TU154 and lost the contract to the newest plant built from 1985 onwards at Ulyanovsk. "(Tyuchtin 1993)"

However, the dramatic change of and relationships with the customer was made very clear by "(Gorlov 1993)" when he stated, the Committee on Military Branches of Industry has not given a new order for military aircraft for three years and the Design Bureaux and manufacturing plants are now ultimately responsible for finding their own customers. The Ministry has the Development Programme of Civil Aviation 2000 which, as of July 1993, pledged support for the development of the models IL96, IL114, TU204, YAK42, BE200, AN70T, M138 and light aircraft. The Ministry agreed to buy some of the new generation aircraft, such as IL96 and give companies favourable credits with purpose of embedding in the new generation of aircraft as soon as possible.

The second major change, as stated by "(Shorin 1993)" to impact on this stage was "Before August 1991, 60 per cent of the science and research budget came from the State and 40 per cent from industry. By the middle of 1992, the Research Institutes had stopped receiving funds from industry and the share from the state had decreased threefold. Added to this, the most advanced scientists were concentrated in the military context and the military complex is now in the disastrous process of conversion. There is also a critical lack of State investment in industry and with the State restriction, industry has a long and painful process of recovery, but meanwhile is plunging deeper into the situation of being the 'raw material appendage to the West'."

This competitiveness now also applies to the Engine Plants. The Ministry used to
direct, to some extent, which plant produced the engines, but now it depends on the availability of capacity and potential financial support by the engine plant for final development work and sales. In this they are supported by the two major Bureaux, the Kuibyshev Scientific and Production Association (TRUD), designing Kuznetsov engines and PERM Scientific and Production Enterprise with its PERM engines. The engine contract for the Beriev BE103 was bid for by three plants because they could see that it could be made quickly and be sold to the third world countries. The contract went to a military plant which could fund the development and had experience of selling military aircraft to the third world. "(Konoplev 1994)"

Also as a result of these changes the Ministry orders for civilian aircraft given before the formation of Aeroflot Russian International Airlines (ARIA) as a joint stock company, have been delivered, but only minimal payment has been forthcoming with, for instance, the powerful Ilyushin Design Bureau "(Katyrev 1993)" and the Frunze Motor-Building Production Association "(Shitarev 1994)" being the most successful in receiving one third of the payments due to them. The government credit notes, mentioned by Gorlov, are the major medium of exchange and are the prime source of potential payment for all the actors in the supply chain. However, as the governmental financial crisis increases this medium of exchange is becoming discredited and ineffective. For instance, the Samara AVI.S aircraft building plant was owed billions of roubles with the result that, in 1994, they were working only a three day week, with a high proportion of that time being spent producing civilian goods. In April 1995 the plant went into bankruptcy. The arbitrage court had to determine the future of the plant and the main creditor, the government, agreed to wait for 12 months for payment of unpaid taxes and on the 16th of September a moratorium was agreed on these taxes. The court agreed also on a new management team who had to put forward a rescue plan by October 1st. This was accepted by the court. Some indication of the impact of the collapse on the Samara economy can be envisaged.
when one recognises that the plant had 25,000 employees with a monthly salary bill of some 3 billion roubles (at 3000 roubles to $). The debt as of October 1st was 133 million roubles. This compares with the production of 1000 TU 154’s to date generating an income of some $10 billion dollars in the last 25 years "(Khasis 1994)". In addition the plant covers 3000 Russian hectares and houses 1 million square metres of flats for its employers, has its own brickworks producing 5 million bricks a year for its own use, and its own agricultural land, pigs and cattle to feed the staff. Their social obligations also included the building, maintenance and running of 3 large hospitals, 18 kindergartens and 2 staff holiday camps. One awaits the outcome of the efforts of the new management team, especially in their efforts to manage this "feudal village" and sell the TU154 using various financing deals including those with Russian government and the leasing company T.T.G in USA. The difficulties experienced by this plant are reflected generally in the majority of Russian aircraft and engine manufacturing plants resulting in the restructuring of the top management teams in most of these plants.

The 'authoritarian paternalist hierarchy' is still present in the aircraft manufacturing plants in Samara and Ulyanovsk but Tyuchtun's experience, as the ex-director of the AV1.S plant of having staff sit outside this office for whole days and refusing to leave until their individual problems have been addressed and concessions given, may be receding with the enforced 3 day week and the financial crisis at the plant.

COMPLEXES

To attempt to overcome the problems of limited government funds and a backlog of payments on aircraft already bought by the government, Complexes are being created of design bureaux, experimental aircraft manufacturing, engine and avionic plants
and Russian sub-contractors in order to sell the aircraft to help fund the next one and are linking with Russian and foreign banks and financial institutions (figure 5) so that they have no need ‘to beg for money’. "(Konoplev 1994)" For instance, the Ilyushin Design Bureau, with Chernomyrdin’s approval in April 1994, joined the Voronezh Aircraft Plant, the experimental plant, Avia Exports, previously the State Export Agency and some banks to form the Ilyushin Corporation, where the new board will make the decisions. The major decisions will include Western collaboration, the fixing of the price for the aircraft, when to deliver, certification, maintenance and service and delivery of spares. "(Katyrev 1993)" Beriev have also set up BETA Air, made up of Geneva ILTA Trade Finance SA of Switzerland, the GM Beriev Taganrog Aviation Scientific Technical Complex (TASTC), the Taganrog Aviation Production Plant (TAPO) and Irkutsk Aviation Production Plant (IAPO). "(Konoplev 1994)" TRUD has joined with the Kazan Design Manufacturing Association, the Design Bureau for Engines, the Engine Plant in Samara, Kazan Engine Plant and JS Company “Metallist” Samara to form the TRUD complex, again run by its board of directors. "(Gritsenko 1994)" In fact all of the bureaux and plants are now negotiating the formation of these complexes. This dramatic change in the formal relationship between these actors will impact upon the network structure.

DISCUSSION

The stable innovation system created under the Soviet planning system, with its guaranteed supplies to and huge home market for civilian and military aircraft stimulated this "enclave of competence in a congealed system" in terms of aircraft design, development and manufacture. The sophisticated network of actors linking the government, universities, research institutes, bureaux, plants, sub-contractors, certifying agents and customers is adjusting to the post Perestroika world relatively
quickly. However, at the same time, it is trying to ensure that the key elements of the network stay in place to ensure continuity and protection of the invaluable stock of knowledge and experience built up over the 50 years of development.

The change in the balance of power and relationships between the old and new actors, the changing resourcing strategies and the realignment of activities in the network are creating a new world order for the aerospace industry. The most intriguing activity in this new order is the creation of the complexes across the industry and their likely impact on the network. This phenomenon may be difficult to isolate among such turbulence, but it is the focus of my future research.
BIBLIOGRAPHY


Komarov V A (1993), Technology of Automated Design of Aviation Structures, Samara Aviation Institute, Samara, Russia.
Komarov V A and B Shaw (1995), (Figure 2) "The Innovation Process in the Russian Aerospace Industry".

Koptev A N and B Shaw (1995), (Figure 1), "Network in the Design, Development and Manufacture of Aircraft in the Russian Aerospace Industry".


REFERENCES

Balakin Victor L (1993), Vice-Rector Samara State Aerospace University, Samara, Russia.

Ermolov Oleg (1994), General Director Samara State Enterprise AviaaGregat, Samara, Russia.

Gorlov Victor V (1993), Deputy Department Director, Ministry of Transport of Russia, Department of Air Transport, Moscow, Russia.

Gritsenko Eugeny A (1994), President Kuibyshev Scientific Production Association (TRUD) Samara, Russia.


Katyrev Igor Y (1993), Chief Designer, Ilyushin Aviation Complex, Moscow, Russia.

Khasis L (1994), Managing Director of AVI.S Plant Appointed by the Arbitrage Court.

Komarov Valery A (1993), Academician, Professor, Chair Aircraft Structural Design, Samara State Aerospace University.

Konoplev Vladimir N (1994), Assistant President G M Beriev Taganrog Aviation Scientific Engineering Complex, Taganrog, Russia.
Koptev Anatolii N (1993), Professor, Aircraft Design, Samara State Aerospace University.

Samoylovich Oleg S (1993), Professor, Aircraft Design, Department Chief, Moscow Aviation Institute, Moscow, Russia - Former Head of Design, Sukhoi Design Bureau, Moscow, Russia.

Shitarev Igor L (1994), General Director Motor-Building Production Association after M V Frunze, Samara, Russia.


Sormus M (1994), Managing Director Estonian Civil Aviation Authority.

Trofimov Nikolay G (1993), Chief Designer, Kuibyshev Scientific Production Association (TRUD), Samara, Russia.

Tyuchtin Pavel S (1993), General Director, Avi.S Aircraft Manufacturers, Samara, Russia.

Zarubin N A (1993), Associate Professor, Samara State Aerospace University, Samara, Russia.