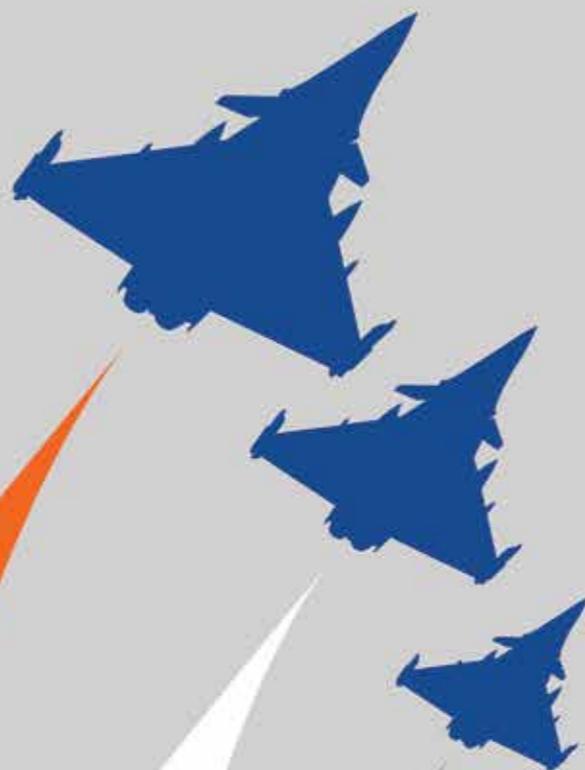


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AIR POWER

Vol. 10 No. 4 • Winter 2015 • (October-December)

# AIR POWER

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(October-December)



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• Arjun Subramanian P • Dr Shalini Chawla  
• Dr Temjenmeren Ao • Group Captain Ashish Gupta  
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CENTRE FOR AIR POWER STUDIES, NEW DELHI

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## EDITOR'S NOTE

The year ends on a sombre note. Wars in Syria, Iraq, Yemen, Afghanistan and elsewhere continue unabated. In all these wars, there are far too many players and diverse interests, and the United Nations and the international community apparently are unable to come to grips with the situation and agree on a possible solution acceptable to most. Till then, the Islamic State in Syria (ISIS), Al Qaeda, Boko Haram et al will continue to wreak havoc. In many parts of the world, militancy and insurgency continue to defy an answer. There is a threat of horizontal and vertical proliferation of nuclear weapons, with increasing threat of use of missiles that could have either conventional or nuclear warheads, thereby creating confusion and difficulties in decision-making. The threat of submarines is increasing and anti-submarine operations are gaining salience. There is growing suspicion amongst independent states, and the recent conferences on climate change and World Trade Organisation (WTO) are mere indications of the malady. Four years ago, the cyber world was recognised as the fifth domain of warfare, and now, use and control of the electro-magnetic spectrum is being recognised as the sixth domain of warfare. Not satisfied with the increased lethality of weapons, major work is afoot in the realm of personnel capability enhancement, to improve the bodies and minds of our military personnel and adversely impact those of the adversary. The picture is gloomy. We live in a troubled world.

Many of the issues mentioned above are included in the articles in this issue but we lead with the remarks of the **Chief of the Air Staff Air Chief Marshal Raha** at the 12th Subroto Mukerjee Seminar. In a wide ranging talk, he covered the roles of aerospace power in conflict situations and during peace, whilst emphasising the importance of technology in the application of aerospace power.

Every year or two, our Defence Procurement Procedure (DPP) is amended and yet the many changes have failed to satisfy the users or the manufacturers. The government took a good decision to examine the entire ambit of the procurement procedure and set up a Committee of Experts for Amendments to the Defence Procurement Procedure 2013 including the Formulation of Policy Framework. The work has been well received and many recommendations made are likely to feature in the next procurement procedure that will be issued. **Shri Dhirendra Singh** was the chairman of the committee and in a well reasoned article, he describes the need for a paradigm shift. The article will remain an important work in a field that has so far defied an acceptable approach.

Nuclear issues continue to be debated and the romance with matters nuclear is as strong as ever. Much has been written about the reasons why India chose to shift from 'peaceful uses' to weaponisation. **Arjun Subramanian P** takes a somewhat different tack. He assesses the Indian nuclear programme from the 'material' perspective from the beginning and extrapolates to the requirements in the future. Pakistan's tactical nuclear programme is also examined. The article is a good read and informative.

The much touted drawdown of forces from Afghanistan was supposedly completed in December last year but the country remains in a troubled state. What the future holds is unclear. Pakistan would like to continue its dominant position but the relationship has had its ups and downs. China and India also have their own interests and the situation remains uncertain. **Shalini Chawla** attempts to decipher the situation and unravel the intricacies.

The US-China relationship is the defining debate at present and it has undergone major changes in the recent past. **Temjenmeran Ao** traces the recent history and asks the important question as to whether the US has been soft on China. Chinese nuclear proliferation is described in some detail and the author argues that the proliferation has been near accepted because of strategic and commercial considerations, in a major departure from stated US policies.

The world views the cyber sphere with some excitement and apprehension. The potential of cyber attacks in their myriad forms is now recognised as a reality. The attacks are also becoming more effective and wide-ranging. The term Distributive Denial of Service is gaining currency. In December 2015, some 400,000 websites in Turkey were brought down in a week. That is indicative of the power of cyber attacks. One form of cyber attacks or system to facilitate such attacks is to introduce bugs in the hardware. **Gp Capt Ashish Gupta** looks at how hardware exploitation can be achieved.

Many of us bemoan the lack of a flourishing aerospace industry in India. So much needs to be done. It is instructive to see as to how the growth of indigenous industry was brought about in other countries. In a detailed account, **Gp Capt Vivek Kapur** looks at the development of the aerospace sector in the USA and in the erstwhile USSR/Russia. There are many lessons to learn for us.

The last article in this issue is about a subject that seldom finds a place in this journal. In an academic theoretical article **Gp Capt M Misra** discusses how a human systems approach can make the application of air power more effective.



Happy reading

# INDIA'S SECURITY CHALLENGES: ROLE OF AEROSPACE POWER

INAUGURAL ADDRESS BY CAS  
12TH SUBROTO MUKERJEE SEMINAR

ARUP RAHA

## INTRODUCTION

Air Chief Mshl SP Tyagi, Air Mshl Vinod Patney, director general, Centre for Air Power Studies (CAPS), serving and retired officers, eminent scholars; distinguished guests, ladies and gentlemen. I am honoured to be amidst such a learned audience, at the inauguration of the 12th Subroto Mukerjee Seminar on “India’s Security Challenges: Role of Aerospace Power”.

My compliments to CAPS for its unique and sustained contributions towards promoting awareness in the aerospace domain and organising thought provoking seminars on contemporary issues related to the security challenges of the nation.

## AIR MARSHAL SUBROTO MUKERJEE

I would like to begin by paying tribute to the vision and leadership of Air Mshl Subroto Mukerjee, the first Indian to command a flight, squadron, wing and eventually go on to become the first commander-in-chief and chief of the Air Staff of the Indian Air Force (IAF) at age of just 43. The ingenuity and leadership displayed by him in **saving an army post** from the tribal onslaught in the North-West Frontier Province (NWPF) in 1940, is legendary. He was

---

Air Chief Marshal **Arup Raha** PVSM, AVSM, VM, ADC, is the Chief of the Air Staff, Indian Air Force.

responsible for literally nurturing the fledgling IAF and guiding its destiny during its crucial formative years. Much of what we are today is a result of his astute guidance and visionary leadership. Air Mshl Subroto Mukerjee will always find a special place in the heart of every air-warrior.

## **SUBJECT**

The theme of the seminar has been aptly chosen as “India’s Security Challenges: Role of Aerospace Power”.

**Global Security Environment:** Constant churning in geo-politics and geo-economics has thrown up new challenges in the global security scenario. The 9/11 terrorist strikes in the US mainland brought about greater international convergence on security issues and tackling of sub-conventional threats and challenges. New threats have reinforced the need for international cooperation to combat them. It has found expression as GWOT – Global War on Terror. The Arab Spring and Jasmine Revolution have altered the character of regional politics in Northern Africa and West Asia. It has led to regime changes in Egypt, Libya and Tunisia and fuelled instability in the region. The rise of the Islamic State (IS) and unrest in Syria and Iraq have created instability in the Middle East and caught the attention of the entire world. Economics, energy security, national interests as well as religious ideology are shaping views on geo-politics and national and international security. The rise of China, India and the Association of Southeast Asian Nations (ASEAN) has resulted in the shift of the economic centre of gravity and, hence, the strategic centre of gravity, to the Asia-Pacific region.

**India and its Neighbourhood:** India shares 15,100 km of mostly inhospitable land boundaries with six countries and its seventh neighbour, Sri Lanka, is separated by just 25 miles of a shallow water channel. This is a unique challenge for any country, as the dual task of physical security of the borders and maintaining harmonious relations with neighbours is a humongous one.

**External Security Challenges:** Today, the issues range from border disputes, the fallout of the uprisings in West Asia, the rise of the IS,

instability in Afghanistan and Pakistan and the withdrawal of US troops from Afghanistan at a critical phase for the Afghan government. These are major concerns not only for India but the entire world. Additional challenges include ensuring continuous access to space and enhancing the cyber domain, as future wars are likely to be fought silently in these domains. We need to be prepared to deal with them proactively.

**Internal Security Challenges:** In an ever changing security scenario, it is becoming increasingly difficult to separate the internal threats to security from the external ones. The threats to India's internal security emanate from terrorism, insurgencies in the northeast and the Naxalite movement. In fact, in the recent past, Naxalism has emerged as the single biggest threat to India's internal security and has assumed serious and threatening proportions. Economic development in the northeastern region has been slow. Thus, this region remains a weak area in maintaining border sanctity, as also very vulnerable to illegal immigrants and insurgents.

**Composite Threat to Security:** The security challenges faced by India are varied, complex and dynamic. Our most immediate and primary threat is that of terrorism. However, the constant conventional threat to our borders cannot be overlooked. Our national objectives should, therefore, be aimed to avoid conflict through deterrence. Hence, India will have to build capability across the entire spectrum of conflicts—sub-conventional, conventional to non-conventional. Our procurement plans must be in consonance with the aim to possess strategic reach that would serve the ends of military diplomacy and enable force projection within India's strategic area of influence.

## **ROLE OF MILITARY POWER**

In the current security environment, and with the growth of the nation as an economic power, its Human Resource (HR) development, science and technological base, with enhanced Comprehensive National Power (CNP), India will have to play its role in the international arena. We are destined to play a stellar role in ensuring peace and stability in the region, if not the

world. Therefore, we have no option but to invest adequately in developing military power.

**Composition of Military Power:** The factors that influence military force structure planning are, firstly, the threat perception and its mitigation; secondly, national objectives and aspirations. These, in turn, govern the size and composition of the armed forces. For the army, it would determine the number of strike corps; in the case of the navy, the number of aircraft carriers and nuclear submarines; and for the air force, its offensive capability, strike power and other force enhancers.

### **NATIONAL OBJECTIVES**

- Our national policies are enshrined in the form of declarations in the Panchsheel, Non-Aligned Movement (NAM), United Nations (UN), etc.
- India has no territorial ambitions. However, we have hostile borders and border disputes. We have fought several wars on this account.
- Our broad objective is, therefore, to avoid conflicts and deter war. However, deterrence can be achieved through appropriate offensive capability.
- Aerospace power, with its unique attributes of speed, reach, footprint and precision, is the best national instrument for defence and deterrence.

### **ROLE OF AEROSPACE POWER**

The IAF, along with Indian Army and Indian Navy, with their core competencies, including aerospace elements, are poised to contribute in stabilising the region. They provide for enhancing the nation's strategic presence/footprint. Aerospace power will be the first respondent in any contingency, peace or war. Aerospace power in the maritime domain would play an important role in dominating the seas and protection of island territories. While aircraft carriers and Maritime Reconnaissance (MR) assets of the Indian Navy (IN) are being augmented, the shore-based Maritime Air Operations (MAO) by the IAF would provide more teeth in offensive operations.

**IAF Roles:** The IAF has been performing roles in three categories to mitigate national security concerns. These include, i.e. classical roles, peace-time roles and roles in conventional conflict. As a multi-spectrum strategic force, the IAF performs these three classical roles which include:

- **Firstly, Power Projection:** Aircraft such as the SU-30, flight refuelling aircraft, airborne warning and control system, C-17, C-130, etc have enhanced our strategic reach and footprint. Certain capabilities have been aptly demonstrated during the humanitarian aid and disaster relief operations in Yemen and Nepal.
- **Secondly, Credible Deterrence:** A credible IAF with appropriate force levels and precision weapons has been one of the major contributory factors in deterring a major conflict since 1971.
- **Thirdly, Protection:** What often goes unnoticed is the 24x7 air defence provided by the IAF to protect the sovereignty of the nation's air space frontiers. With more than 6,000 civil and 1,500 military flights daily, radars keep churning, and fighter aircraft and helicopters are kept ready for armed action, if required. However, the biggest challenge shall remain the mitigation of unregulated sub-conventional aerial threats which include drones, gliders, microlites, etc. Review of Civil Aviation Requirements (CARs) and procurement of Close in Weapon Systems (CIWS) are underway to meet this evolving challenge.

#### PEACE-TIME ROLES

- **Air Maintenance:** Air maintenance in the northern as well as northeastern sectors is the lifeline of the ground forces securing our borders and the IAF lifts close to 35,000 tonnes annually by fixed and rotary wing aircraft.
- **Infrastructure Creation:** Assistance to the Border Roads Organisation (BRO), Indian Railways and other government agencies is being provided on a routine basis to create infrastructure in remote areas to enhance security.
- **Internal Security:** The needs of the Ministry of Home Affairs (MHA), Election Commission, etc. are being addressed, as and when the contingencies arise.

- **Op Triveni:** Logistics support to paramilitary forces engaged in controlling Left Wing Extremism (LWE) is another major peace-time task being performed by the IAF. Since 2009, the IAF has flown substantial number of sorties to airlift a large numbers of personnel and logistics supplies.

### **CONVENTIONAL CONFLICT: USE OF AEROSPACE POWER**

**Control of the Air:** The primacy of gaining control of the air to wage war successfully along the entire spectrum shall always remain. Control of the air is a critical factor and the conduct of future wars will increasingly depend on the degree of air control. However, modern short and swift wars do not offer the luxury or the time to conduct a protracted counter-air campaign. This has given rise to the concept of dynamic air dominance and increased emphasis on achievement of favourable air situation to allow for the conduct of specific operations. Dynamic targeting is set to assume greater significance in the coming years. All air campaigns will be fought in parallel or simultaneously. The integrated Air Defence (AD) network, Integrated Air Command and Control System (IACCS), Akash Teer and Triguna will ensure efficient air space management, especially in the Tactical Battle Area (TBA).

**Surveillance and Reconnaissance:** The essence of air power is targeting, which in itself is entirely dependent on intelligence. The importance of the peace-time role of surveillance to build strategic databases cannot be overemphasised. While the sensors and means of data analysis and storage have undergone a change, digitisation has offered greater access to large amounts of databases in quicker timeframes. A mix of space-based assets, fighter aircraft, Remotely Piloted Aircraft (RPA) and even helicopters equipped with suitable sensors provide the IAF the necessary data acquisition capability. Tactical reconnaissance is another area where the IAF has made substantial progress with the induction of Electro-Optic/Infra-Red (EO/IR) pods and Synthetic Aperture Radar (SAR) pods for fighter aircraft.

**Precision Targeting:** The advent of Precision Guided Munitions (PGMs) has always been considered as a major turning point in the employment of

air power. Modern short swift wars, with dynamic targets and minimum margin for collateral damage, will demand extensive use of PGMs both in support of ground forces as well as in independent operations in pursuit of strategic effects.

**Air Transported Operations – Rapid Deployment of Troops and Equipment:** Air power will be used effectively for mobilisation through rapid deployment of troops and equipment, be it peace or war. Vertical envelopment at the crucial stages of the ground battle will ensure rapid progress of ground operations. Air maintenance of forward areas as well as ground forces and casualty evacuation are lifelines and crucial morale boosters during actual operations.

#### **TECHNOLOGY AND APPLICATION OF AEROSPACE POWER**

Aerospace power requires synergistic integration of air, space and information systems to achieve strategic military objectives. Cutting edge technology in every aspect such as efficient engines, lighter airframes, miniaturisation, smart weapons, radar and stealth technology, navigation and targeting systems, space enabled capabilities for communications and surveillance, accurate position and navigation information, and ballistic missiles have transformed the nature and application of aerospace power in military doctrines over the last century. The space-based satellite programme will provide the Position, Navigation and Time (PNT) and the Indian Regional Navigation Satellite System (IRNSS) capability.

#### **ROLE OF AEROSPACE POWER IN FUTURE**

The application of aerospace power would prove to be the **decisive factor** in winning the military campaigns, wherein the response has to be prompt and precise. Hence, one of the major challenges is to remain a contemporary aerospace power with credible response options. In the light of the expanding strategic footprint of a resurgent India, the IAF must possess complementary capabilities to operate effectively and decisively. With this aim in mind, the IAF's transformation plans aim at acquiring multi-

spectrum strategic capability. The capability involves replacement of legacy systems, upgradation of existing systems and platforms and induction of state-of-the-art equipment.

### **CONCLUSION**

I thank CAPS once again for inviting me today to talk about this important subject in this seminar. I am sure seminars like these would help in strengthening our collective strategic mindset. My best wishes to all the participants of this seminar for fruitful deliberations.

# DEFENCE PRODUCTION AND ACQUISITION POLICIES: SUGGESTIONS FOR A PARADIGM SHIFT

**DHIRENDRA SINGH**

It is a well understood axiom that scientific progress is not easily predicted, and that in most cases, its pace has been underestimated. This can now also be said of technological progress, especially after man mastered the strength of the computer and the digital world. In 1903, the venerable *New York Times* declared that thinking about flying machines was a waste of time. This, when Aeronautical Societies (soon after men went up in balloons) had been in existence for more than five decades and flyers, especially in Germany and France, had been using gliders for quite some time. The German Otto Lilienthal, a mining engineer by training, disenchanted by balloons, wanted to replicate the free flight of birds and had been experimenting with gliders since 1869. Other well-known names who were interested in gliders were Maxim, the inventor of the machine gun, Alexander Graham Bell and Thomas Edison. The mechanics of bird flight had been closely studied by Chanute, a French-born American civil engineer, and Langley, an astronomer and head of the Smithsonian Institution. Yet the cynicism of the *Times!* But what is of significance is that the *Times* article came just one week before December 17, 1903, the day the Wright Brothers made the first heavier-than-air powered flight at the wind swept beach of Kill Devils Hill at Kitty Hawk in North

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**Dhirendra Singh** is a former Special Secretary, Defence Acquisition, and Union Home Secretary. He chaired the Expert Committee on DPP 2013 including Formulation of Policy Framework, which submitted its report to the Government of India in July 2015 . He is an Honorary Distinguished Fellow of CAPS.

**It becomes necessary, therefore, to spend time and thought on getting the fundamentals right before embarking on a difficult endeavour. A misstep can lead to huge cost overruns, not to mention wastage of time which can be incalculable.**

Carolina, USA. There were other minds at work, and the Europeans, especially German scientists, had sought to tackle the problem by concentrating on the thrust and power of the engine. In spite of their dedication and earnestness, they had set about the wrong road whereas the Wright Brothers initially ignored the engine and concentrated on flight control (actually spending years studying birds in flight) and set about mastering the 'lift', 'pitch', 'roll' and 'yaw' or, as they termed it, maintaining the equilibrium and lateral control of the machine – the subjects of the patent they filed for in 1903, and obtained in 1906. The engine itself they had left to their assistant in the bicycle shop, Charlie Taylor, who fashioned the gasoline-fired four-cylinder engine and this much after they were satisfied with their glider flights. It is another matter that those who had taken the engine-centric road achieved success elsewhere. The German Messerschmitt 163 manufactured in 1944 (preceded by the invention of the jet engine by Frank Whittle) was a rocket driven fighter good for extremely high altitudes. And this road led to the development of rocketry and space travel, putting a man on the moon in 1969, just 63 years after the first flight.

It becomes necessary, therefore, to spend time and thought on getting the fundamentals right before embarking on a difficult endeavour. A misstep can lead to huge cost overruns, not to mention wastage of time which can be incalculable. What is true for science and technology is also true for policy making, with one major difference. Whereas experimentation is the norm in scientific research, it needs to be discouraged in policy formulation.. The aforesaid technological analogy is given because of its relevance to defence manufacture – a highly technology-centred enterprise. The several strands which need to be gathered together are innovation and research; institutional and financial arrangements; encouragement by state authorities; attitudinal changes amongst regulators and procurement agencies; sharing

of resources; and, above all, government patronage which needs to be extended to all those who have the potential to contribute in this national enterprise. While all these factors are true for any enterprise, defence manufacture has its own distinctive features. These need to be recognised as they have an important bearing on how the infrastructure and processes need to be organised. Moreover, defence material needs to be understood in the context of user mastery of the equipment, battle doctrines and, above all, the strategic environment in which nations pursue their security goals. Analysing the alternatives and studying the best practices elsewhere are the tools for such an enterprise. Whereas scientific innovation and discovery can be left to the genius and dedication of individuals, policy making needs to be a structured communal exercise, within the confines of the legal and constitutional framework. This paper seeks to lay out the road which needs to be taken.

**Scientific innovation and discovery can be left to the genius and dedication of individuals, policy making needs to be a structured communal exercise, within the confines of the legal and constitutional framework.**

A slight diversion may help in putting the development of the Indian defence industry in its historical perspective, at least in the modern era. The East India Company (EIC) started off as a trading company with a factory (actually a warehouse for temporarily storing goods) established at Surat, soon after getting permission to trade peacefully in India, in 1615. The number of such factories continued to grow, with nearly 23 working by 1647. However, the transfer of Bombay to the English from the Portuguese as part of the dowry of Catherine of Braganza, sister of King Alfonso VI, when she married Charles the Second of England in 1662 (actually effected in 1665), led to the English acquisition of a fort built earlier by the Portuguese. (The English had, by 1644, already completed the construction of Fort St. George on a 10-km-long strip of land obtained on lease from the Raja of Vijayanagara but unlike Bombay, Madras was a safe haven). Thus, Bombay became the site of the first manufactory established by the East India Company, a gunpowder mill built in 1669. Arsenals became

an integral part of the defensive fortifications. However, the company directors in London were averse to sharing technical knowledge for weapon manufacture with the Indian workers. But the fast pace of transformation of the company from a trading to a military power soon necessitated some minimal establishment of weapon manufacture facilities in India. A gun foundry came into existence in Fort William at Calcutta in 1770. Soon thereafter, in 1775, the Board of Ordnance was established. This centralised all control over ordnance matters, including contracting, manufacturing, laboratory testing and supply. Many mills, carpentry and smithy shops were established but traditionally Cossipore has the distinction of continuing its operations uninterrupted since 1801-02. The gun foundry at Fort William was transferred to it and it also undertook the manufacture of gun carriages. Manufacture of ordnance in India helped in territorial expansion but the First War of Indian Independence in 1857 led to a major rethink in the imperial ordnance policy which did not prefer local establishment of sophisticated military products. The fact that Indian manufacture at Cossipore was more expensive than that at Woolwich further strengthened the argument against local manufacture. There were two other factors – one, a structural change in the military establishment which amalgamated Indian regiments with the Royal Artillery and, two, the invention of the rifled gun, using steel instead of brass. Both developments mandated production of sophisticated military items in England, and import into India. This policy continued until India gained independence but the lack of knowhow continued to have its deleterious impact and, unwittingly, the policy of keeping out the private sector from defence production further compounded the problem.

As early as in 1753, the British shifted the naval dockyard from Surat to Bombay. Parsi entrepreneurs who were master builders of commercial and naval ships, prominent amongst whom was Lowjee Nusserwanjee Wadia, selected the dockyard sites in Bombay. During the course of the next hundred years, the Bombay naval dockyard built nearly 115 war vessels and 144 merchant ships, including 84 gunships for the Royal Navy. Even today the oldest British warship afloat is the HMS *Trincomalee* built in 1817. All of them used Indian teak as the basic raw material. However, ever cautious

in building modern construction facilities overseas, warship construction in Bombay was allowed to languish. Building aircraft carriers and submarines was out of the question. However, the Indian Navy, modelled on the Royal Navy pattern, had in-built design capabilities as an institutional set-up and this has been a boon. It demonstrated in addition to its design capabilities a greater propensity to collaborate with the Defence Research and Development Organisation (DRDO). It is quite significant that all the ships presently under construction are being built in Indian shipyards (including some in private shipyards also). A major milestone was reached with the launch of India's indigenous aircraft carrier (*Vikrant*) in August 2013 at Cochin Shipyard Limited. The transfer of technology arrangements under the Scorpene project enhanced the navy's design capabilities in submarine construction. Because of a separate design infrastructure embedded in the navy's institutional framework, its interaction with industry and research bodies has been more intense. Such a tradition did not exist in the army and air force, which relied, the former for its vast array of equipment, and the latter for its sophisticated airborne systems, on private enterprise or dedicated ordnance establishments outside the formal military structure.

Aerospace technologies being a 20th century innovation, never really got off the ground in India. A factory meant to produce rifles was conceived in Kanpur in 1942 but it was ultimately used for repairing and overhauling aero-engines of the Royal Air Force (RAF). The credit for the first attempt at building an aerospace industry in India goes to Walchand Hirachand Doshi. Hindustan Aircraft was started in Bangalore with the active support of the princely state of Mysore in 1940. The Government of India became a partner in 1941 and thereafter took over the company by the acquisition of a majority of shares in 1942, perhaps not being very keen to allow a private industry to continue in a strategic sector during war-time. It was renamed as Hindustan Aeronautics Limited (HAL). The factory at Kanpur was merged with HAL. (It is interesting to note that another of Walchand Industry's projects, the shipyard at Vishakhapatnam, met a similar fate and was fully converted into a government undertaking in 1961 and named the Hindustan Shipyard Limited).

**The Department of Supply, set up as a part of the Ministry of Defence (MoD) was to encourage private industry but only as an adjunct to the public sector. It was to be a mere works contractor, with no substantive role envisioned for it in defence product manufacture.**

The industrial policy promulgated soon after Independence as well as the development model adopted veered towards a centrally planned model. Thus, the public sector was given prominence in industrial production, and many industries were, in fact, reserved for it, including the defence industry. The exact reasons are difficult to discern, more so because, apart from the Ordnance Factory Board (OFB), other defence related industrial establishments had been privately owned.

Perhaps the ideological bias, directed more towards the civil sector, was so strong that it unwittingly absorbed the defence industry also within its ambit. Policy directions were provided by Prof. PMS Blackett, a Nobel Laureate, who was also a defence equipment innovator, who suggested a two-phased programme aimed at meeting local threats in the first instance, with attention being paid to long-term threats at a subsequent stage. His recommendations led to the formation of DRDO, a decision of considerable significance. Some concessions were made post the 1962 Chinese War on the basis of the recommendations of Arthur D. Little, the US-based management firm. The Department of Supply, set up as a part of the Ministry of Defence (MoD) was to encourage private industry but only as an adjunct to the public sector. It was to be a mere works contractor, with no substantive role envisioned for it in defence product manufacture.

Indigenous efforts which relied mainly on the OFB and the Defence Public Sector Undertakings (DPSUs) did not have the desired impact, and imports continued to rise. Moreover, there was a large import content even in the indigenously manufactured products. The result is that today India accounts for nearly 15 percent of total world imports of defence material. In the pre-1990s bipolar world, although the non-aligned position which India adopted kept it equidistant from great power politics, the bulk of

defence equipment imports was from the Soviet Union. India, consequently, did not build a robust contract management system. The industrial practices conformed to Soviet practices, with a number of advisers locally posted in India. Dedicated complexes for overhaul and manufacture were established for tanks, armoured personnel carriers and aircraft. This is not to say that Western sources were totally neglected. The UK continued to be a big supplier in the initial phases and many capital ships and aircraft carriers were obtained from its naval inventory. Post the 1962 War with China, an air defence radar network was conceived and large radars were manufactured, with technology obtained from Thomson-CSF. In the early 1990s, the break-up of the Soviet Union triggered a major shift in foreign policy and defence cooperation with a number of countries like Israel, South Africa, France, etc. was initiated. Platforms obtained from Russia were fitted with sub-systems obtained from other countries. The matrix became more complex. This, in turn, exposed weaknesses in the procurement executive.

The US-India defence relations during the Cold War era, in which the US perceived India as very close to the Soviet Union, and India saw the US' arming of Pakistan as contributing to the tensions in the subcontinent, were marked by distrust and minimal contacts. The first comprehensive effort to define a new relationship was the army-to-army contacts put forward in 1991 by Gen. Claude Kirklighter of the US Pacific Command. This, by itself, was breaking new ground, as India had hitherto, in its defence cooperation strategy, not encouraged close contacts between Service personnel, apart from the structured courses in military academies. A more comprehensive relationship was entered into in 1995 with the signing of the "Agreed Minutes on Defence Relations between the United States and India". This

**The result is that today India accounts for nearly 15 percent of total world imports of defence material. In the pre-1990s bipolar world, although the non-aligned position which India adopted kept it equidistant from great power politics, the bulk of defence equipment imports was from the Soviet Union.**

was followed up with the “New Framework Defence Agreement” of June 28, 2005. Although supplies of the AN-TPQ 37 fire-finder artillery locating radars were provided prior to this date, a host of supplies was made and continues to be made since then.

A gradual shift, with an accompaniment of procedural sophistication ensued when ideas like co-production, joint development and joint ventures started becoming commonplace. There was an increasing involvement of the production wing during the commercial negotiations to see that the depth of the technology transfer increased. However, since all these efforts were with foreign governments or Foreign Original Equipment Manufacturers (FOEMs) the earlier negotiating systems continued with little modification. Complications arose not because of the introduction of elements like ‘design knowhow’; greater depth of technology, etc., but in the increase in the number of vendors and the competitive bidding process. Newer concerns related to valuation of technology and determination of life-cycle costs. Thus, the simple world of the buyer-seller relationship was getting transformed, with many considerations surfacing.

2001 was a watershed year when the reservation policy was jettisoned and the Indian private sector was allowed to participate in the manufacture of defence products, albeit with licences. The first set of licensing conditions was promulgated in January 2002. After a period of waiting and a few peremptory steps, it would now appear that initial apprehensions are over and the Indian private sector has made up its mind that it would like to match the established public sector in range and depth. Most of these enterprises are, however, looking for Joint Ventures (JVs) as indigenous knowhow for sophisticated defence products is still lacking. Emphasis shifted to purchase contracts, with transfer of technology. It was but natural for the patent holding companies to transfer as little technology as possible (and certainly no design knowhow). Thus, even with indigenous production, the ‘kit of parts’ continued to be brought in. In many cases, the purchase and manufacture became an obsession, with little effort being made towards indigenous development. The Advanced Jet Trainer (AJT) is a prime example. The desire to have it and seek foreign suppliers emerged

in the mid-1980s and continued for two decades. In the meantime, only one shortlisted manufacturer remained, the other having closed its production lines. Serious attempts were not made to understand the deficiencies in the system or to bring in the expertise and knowledge of those outside the public sector, when, all along, negotiations were going on with the private sector foreign manufacturers.

Post Kargil, two major initiatives were taken. They related to: (a) integration of the various agencies concerned with acquisition into a unified procurement agency, housed in the Ministry of Defence; and (b) promulgation of a more open and comprehensive Defence Procurement Procedure (DPP). Thus, the Defence Acquisition Wing was manned by officers on deputation from the armed forces, the finance experts, and the civil bureaucracy. This brought in a more purposeful approach towards procurement, with the expertise of each profession aiding the others. The DPP itself, being more comprehensive, became a better guide, envisaging different approaches to outright purchase, transfer of technology, and ship building. Policy directives were to be handed down by high level committees headed by secretaries of various departments in the MoD, with an apex committee chaired by the raksha mantri. In spite of these initiatives, it was quite apparent that old habits die hard.

The procurement executive worked on a simplified, low risk matrix. The OFB was a government owned (ironically set up by the East India Company, a joint stock company) and government managed organisation. Its operations were covered for both investment and sales under the Ministry of Defence Budget. Thus, orders were placed on a cost plus basis and supplies made after the Directorate General Quality Assurance (DGQA) quality checks. There were never any serious costing disputes. The same was true for the DPSUs. In fact, parking unspent budgetary allocations under the modernisation programme with the DPSUs against orders placed but where supplies were still to be effected, became quite common. It was also 'safe' to deal with government owned organisations as no one really questioned the amounts paid. Prior to *perestroika* and the break-up of the Soviet Union (which accounted for the bulk of the Indian modernisation expenditure), the

regime of 'political pricing' under a rupee-rouble trading pattern existed. All contracting was done on the basis of standard contracts and there was very little negotiation of any substance. The Transfer of Technology (ToT) arrangements had no design content and minimal transfer of knowhow. The system worked under an arrangement wherein a large number of sub-systems and systems were imported. Since a very large number of contracts was entered into with specified government agencies and they followed a similar pattern, a sense of complacency within the procurement executive was but natural. Another significant issue was that there was no contract with the actual manufacturing bodies (all state owned) on commercial matters. To this extent, there was a major difference in procurement from Western sources, where contracting and negotiations on commercial terms were conducted with the manufacturers directly. However, in almost all cases, the payments were in advance, through irrevocable letters of credit, on the basis of self-certification. Thus, the commercial interests of the manufacturers were safeguarded. Even after revised arrangements were entered into with the Russian Federation, commercial negotiations continued to be with government entities. What was the norm with Russian purchases was also followed for purchases from the USA. In fact, it was much simpler – there was outright purchase (or lease) and under the Foreign Military Sales (FMS) regime, the commercial negotiations were not to be held by the Indian authorities. This was to be done by the US authorities, which followed their own due diligence procedures and negotiated with the private manufacturers on behalf of the Indian government. Thus, all 'risks' associated with commercial negotiations were eliminated. Moreover, having followed the government-to-government route, there was to be no competitive bidding. What was required to be done was to carefully choose the equipment and determine the required quantities. Whenever the competitive mode was sought to be used, difficulties of one type or another arose. The negotiations became prolonged because of pricing comparisons sought to be made in an environment in which there was great opacity on price issues. There was difficulty in arriving at life-cycle costs, the nature and depth of the ToT and its cost. Unfortunately, many of the negotiations

got mired in controversies, leading to cancellations of contracts and black-listing of suppliers. In a recent development, negotiations for part purchase and later manufacture of fighter aircraft in India have been abandoned in preference for outright purchase as the delay was becoming unacceptable and was affecting the defence preparedness.

In this arrangement, there was little scope for serious differences between those responsible for 'production' and those responsible for 'procurement'. As so long as the OFB and the DPSUs had enough orders and the balance sheet was in the black, the Department of Defence Production was not very much concerned with the quantum or orders which did not come their way. In fact, the DRDO was more perturbed when products developed by them were not given due weightage. The armed forces cried foul and blamed the DRDO for its intransigence. The Production and Acquisition Wings could function in their own silos with minimum interaction.

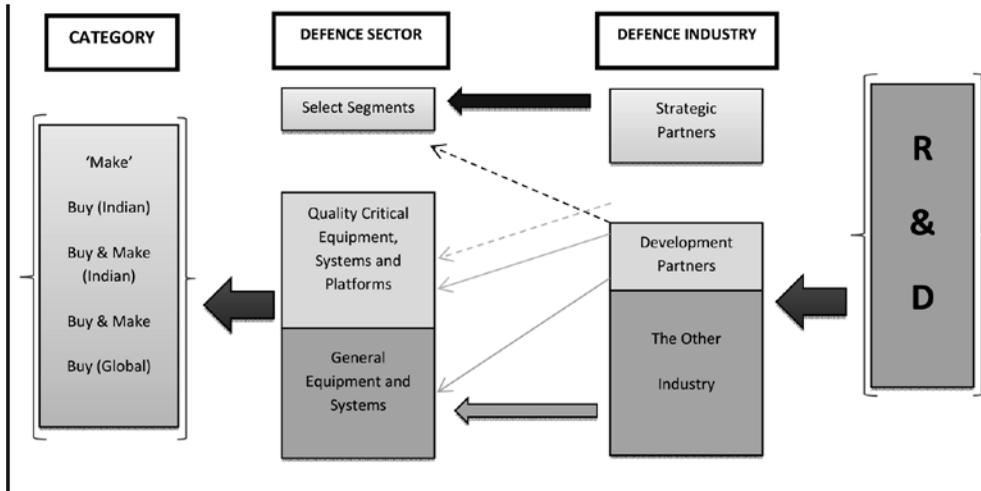
Thus, if one studies the current scenario, one sees a vast patchwork. The public sector, consisting of the OFB and DPSUs, still stands prominent in production but has little indigenous content. Government-to-government relations with the Russian Federation are still strong but the Foreign Military Sales (FMS) route with the US has fast caught up and it would appear that perhaps this route has surpassed purchases from Russia. FOEMs also belong to the UK, France, Italy, Germany, South Africa, Holland, etc. Many bilateral agreements have been entered into and each has a technology transfer content. The DPSUs are also signing up with FOEMs for Joint Venture (JV) projects. The offset regime has forced the FOEMs to search for Indian partners. The Indian private sector industry also consists of diverse elements. There are big industrial houses, which have aspirations of becoming major integrators; then, there are the Tier I, II, and III industries under the nomenclature of MSMEs (Medium, Small and Micro Enterprises) and their numbers run into thousands. Whereas a majority of them would like to be participants in the indigenisation process as suppliers to bigger companies or to the OFB and DPSUs, many of them see themselves as 'innovators', quite capable of coming up with sophisticated indigenous products or solutions. This is quite understandable and needs

to be encouraged, considering that many high technology products in the advanced countries also emanate from small companies. Everyone seems to have an idea of the macro picture but investments need hard facts. The Services made Perspective Plans and government pronouncements are not precise enough for a serious investor to start putting his money on the table. Thus, although a large number of JVs have been formed and licences obtained for diverse products, actual production, based on firm orders, is yet to commence.

The need of the hour is to remove the fog of uncertainty and to set out the fundamentals clearly. This paper commenced with such a statement and it is now proposed to spell these out. Unless this is done and done quickly, the laudable objectives of "Make in India" may not be realised and we may witness the gradual waning of interest amongst private industry for this enterprise. Such fundamentals must address not only policy parameters but also procedure and the structure and functioning of the procurement executive.

The Expert Committee set up by the government in May 2015 to suggest changes to the DPP 2013 as also to look into policy parameters, in its report of July 2015, has made wide ranging suggestions which seek to bring about a rearrangement of the patchwork mosaic and reveal the 'figure in the carpet,' so to speak. Diagrammatically, it is represented thus (Fig 1):

Fig 1



Before the proposed system is explained, it is considered desirable to spell out the building blocks on which the idea rests.

## BUILDING BLOCKS FOR THE PARADIGM SHIFT

### *Unique Properties of Defence Material*

- Whereas efficiency and reliability are the basic requirements of any product, the distinguishing feature of defence equipment is its competitive edge in extremely adverse operational circumstances. Adversaries seek not only to maintain their fighting edge but simultaneously seek to degrade the opponent's capabilities. This is not considered desirable either in civil products or in competitive sports where also winning is a prime objective. In this context, elements like endurance, stealth, built in redundancies, speed and manoeuvrability take priority and since much of these depend on the materials used, there is a constant endeavour to find more suitable materials or combinations thereof. But winning is not merely a function of technical superiority but also of skill in the use of the equipment, the logistics infrastructure, and the tactics adopted. A weakness in one of the links in this chain can have disastrous consequences.

**No country would like to freely share knowhow and a restrictive technology transfer regime prevails. Thus, ToT arrangements are weighted heavily in favour of the sellers.**

- It follows, therefore, that technological upgradation at a much faster pace becomes imperative. And as this happens, the training methodologies and battle doctrines need adjustments. As matters stand today, equipment manufacturers are finding it difficult to chase rapid advances in armament technology;
- The downside of this is that concomitant costs increase because of increased investment in R&D and skill upgradation of the labour employed.

These costs need to be amortised over a relatively fewer number of products, thus, increasing unit costs.

- Such costs imply that at a given time, the armed forces' inventory has a mix of state-of-the-art, obsolescent and obsolete items, all requiring product support over extended timeframes.
- Specialised user trials methods require to be developed in field and laboratory conditions.

#### *Defence Industry a Class Apart*

- Order quantities of platforms and major systems are always limited and not susceptible to mass production. This also impacts on processes as batch production differs markedly from assembly line production. The basic platforms have not changed for decades, but users insist on fitting them with modern cutting edge electronics requiring considerable design work and skilled workmanship;
- This requires skills in system integration.
- The net result is that the number of viable manufacturers tends to be limited. Recent decades have seen mergers and acquisitions on a large scale in the advanced defence manufacturing nations.
- No country would like to freely share knowhow and a restrictive technology transfer regime prevails. Thus, ToT arrangements are weighted heavily in favour of the sellers.

*The Defence Market is Different*

- Purchases being a monopsony and producers being limited, the usual market forces do not work in price determination, and other mechanisms need to be developed to ensure fairness in commercial relationships.
- Export is not always a viable option because of national or multilateral control regimes and stiff competition in the market. Order cycles are prolonged, requiring deep pockets for potential exporters.

**It follows, therefore, that both the political executive and armed forces have a distinctive role in the choice of weapons. The strategic vision sets out the outer contours, and within it, the Services can and should be allowed to determine the inventory.**

*Hand-Holding by Government a Sine Qua Non*

- Without government support, it is impossible for the private defence industry to flourish. The public sector became an obvious choice as it meant control over all aspects, including pricing. A private-public partnership ensued, and privatisation was the next logical step.
- Long-term production plans had to conform to user requirements, and industry was guided by the Services' Perspective Plans. Institutional mechanisms for constant interaction on the aspects of qualitative and quantitative requirements are required to be set up.
- Extensive facilities for user trials in field and laboratory conditions by the government need to be established and shared with producers.

*Strategic Policy, Battle Doctrines and Service Qualitative Requirements (SQRs) of Defence Material to Proceed Hand-in-Hand*

- Armament strength or lack of it dictates strategic policy. Many nations decide to form defence blocs to pursue strategic aims at the cost of individual autonomy. In such cases, the quantum and type of inventory is jointly decided. But for those that pursue an independent defence and foreign policy, there is a much wider choice, but this must be carefully exercised.

- Battle doctrines determine configuration and QRs.
- It follows, therefore, that both the political executive and armed forces have a distinctive role in the choice of weapons. The strategic vision sets out the outer contours, and within it, the Services can and should be allowed to determine the inventory.

#### *Inevitability of Long-Term Partnerships*

- Pursuing strategic goals is a long-term exercise and so is defence R&D and investment.
- Having invested heavily in equipment manufacture, it is necessary that exploitation is allowed over long periods, more so in the case of major platforms, which can have an active service life of more than half a century. This means maintenance, repair and overhaul facilities and upgrade capabilities.
- Thus, relationships need to be built up and maintained not only between the government and primary integrators but between the latter and tiered industries.

#### *Emerging Diverse R&D Models and Reliance on Indigenous R&D*

- Experimental models for R&D need to be encouraged till the right mix is found. Such models could span a wide spectrum, from total government funding to total reliance on private enterprise. In between these could be various combinations of government led; industry led; Services directed; wider participation of academic and specialised research, including academic institutions, etc.
- Setting up of common testing facilities and exchange of manpower between entities.

#### *Developing the Infrastructure for Skill Upgradation*

In the final analysis, all efforts must be concentrated on actual production and system integration. The skill of the workman becomes the crucial factor and the infrastructure to impart such skills and to upgrade them on a continuing basis requires to be set up.

*Continuing to Strengthen the Public Sector Defence Infrastructure*

The emphasis on private sector investment should in no way give rise to apprehensions that the public sector is to be neglected. As things stand, domestic production of defence items is dominated by the public sector. The physical and manpower infrastructure developed over the years is impressive and needs to be sustained. However, there is a strong case to corporatise the OFB to bring in greater efficiency and accountability, and also to affect mergers in the DPSUs, especially the shipyards.

Tested against these parameters, it would be apparent that the course taken hitherto, as described in earlier portions of the paper, in setting up a manufacturing base without the involvement of all national resources, laying down of acquisition procedures based on the wrong premises, and constituting the procurement executive without the participation of all the concerned disciplines, suffers from many deficiencies. While some aspects may require a slight tweaking, others would require a complete revamp.

Lessons can also be drawn from the experiences of other countries. A short survey is attempted here. In the United States, there are few remnants of the earlier 'arsenal system', and the country relies completely on private industry to produce high technology equipment but with parameters set up by the user Services and R&D through the aegis of DARPA (Defence Advance Research Projects Agency). Public sector involvement in defence production through the Royal Ordnance factories and dockyards was the accepted norm in Britain but a shift occurred, beginning in 1970, when the defence industry was set on the road to privatisation. The government continues to hold 'golden shares' in them, but shares are also widely held by the public. In France, one can see production units directly under government control, semi-public firms and totally private sector enterprises which are the fastest growing. However, the domestic market not being big enough to support a large production base with multiple agencies, the government has promoted consolidation of production agencies. Israel follows the French pattern of industries having different ownership structures. The security scenario having remained tense for most of the country's existence, there is heavy reliance on indigenous innovation and upgradation (of imported

hardware) skills. The South African defence industry was, to a large extent, the result of arms embargoes against it because of its domestic policies, thus, compelling indigenous effort. South Korea too is emerging as a major producer, with the government supporting designated defence contractors with specified responsibilities. Russia and China continue with state owned companies, though in Russia, the tendency is now to corporatise them for more efficient management.

Across countries, however, what is discernible is that there has been consolidation, with mergers and acquisitions, and the number of major manufacturing companies is limited. However, they are supported by a large number of MSMEs which have long-term relationships with the system integrators. In addition, small innovative enterprises have found niche markets for themselves. There is close interaction between the government and industry in R&D. Quality control is strictly monitored and self-certification is encouraged against specified standards.

What is also of significance is that in almost all countries with advanced defence technologies and a large production base, the production and acquisition executive has a unified structure for better coordination. Thus, the same authority is responsible for R&D, production and acquisition activities. Prominent amongst such organisations are the DGA (Direction Generale de L'armement) of France; and the Defence Equipment and Support Agency (DESA) of the UK. Such unified structures provide better arrangements for coordination and avoid intra-departmental conflicts. This is vital as the interests of production agencies do not always coincide with the work ethos of the acquisition agencies.

Government support and encouragement has been a distinctive feature. The zeal, industry and dedication of the Wright Brothers were matched by the support they got from established institutions. Convinced that human flight was possible and that they wanted to conduct a systematic study of the subject, they wrote in May 1899, to the Smithsonian Institution in Washington for published papers as well as a list of all other papers in the English language. The Smithsonian responded in good measure. It was also not a mere coincidence that the first flight took place 1,000 km from Dayton,

the home town of the Wright Brothers, in the wind swept beaches of a small island off the shores of North Carolina at Kitty Hawk. On queries made by them, the Weather Bureau in Washington provided details of monthly wind velocities at more than 100 Weather Bureau Stations, drawing their attention to the remote spot on the outer beaches of North Carolina. It was only after the initial successful flights that they experimented nearer home at a place some 10 km away from Dayton, at a private farm called Huffman Prairie.

There is a lot of discussion currently about innovation and start-ups. But such concepts require manoeuvrability and quick response times. Military projects tend to languish in the “prototype phase” for long periods, whilst commercial technologies are conceived of, built, and marketed, in much lesser timeframes. Even in the US, the Joint Tactical Radio System conceived in 1997 was shut down in 2012, never having moved out of the prototype mode. Innovations require flexible contracting structures. Even the DARPA system has been characterised at times as “anarchic and byzantine”, although it is known to display innovative zeal such as by taking recourse to “democratised, crowd source innovation,” through its cyber fast track mechanism, it made use of a talent set from amongst hackers for its cyber security initiatives. Such skills will be increasingly required in automated warfare as use of robots and Unmanned Aerial Vehicles (UAVs) increases.

Apart from such conceptual issues, there are a few matters which need attention. These relate to materials and structure of the design apparatus. Wood species like ash and spruce were preferred in the early stages of aircraft manufacture, giving way to bonded plywood. The Short Brothers, in the “Silver Streak” manufactured by them, ushered in the all metal stressed skin bi-plane. Materials now in use are aluminium, titanium and magnesium alloys, plastics and carbon composites. Use of rare earth elements contributes to distinctive metal characteristics. Thus, knowledge and knowhow of material technology becomes crucial. Likewise, the institutional mechanisms must be carefully considered and established. Various models can be adopted. Continuing with the analogy of aircraft design and manufacture, the start point can be the germination of an idea

**Equipment, which requires long-term commitments for repair, overhaul, spares, and upgrades is sourced through multiple short-term contracts, requiring repeated negotiations from different suppliers.**

and then working on the operational problems to get the finished product. In the early phases of aircraft design, generally, a single individual would come up with an idea and, thereafter, supervise the manufacturing process. The case of the Vickers-Armstrong Spitfire is one the most celebrated, for in this case, RJ Mitchell came up with the idea. The Spitfire was not the outcome of iterative modifications of existing types. It was an original idea spawned in the mind of an individual. Others followed, and the aircraft bear their names like de Havilland or

Sikorsky. However, the sheer complexity of modern technology inevitably led to team generated designs. Such teams would include designers, engineers, works managers, and production experts. It was noticed that such team designed aircraft were less liable to develop serious faults at later stages. One immediately recalls names such as Artem Mikoyan and Mikhail Gurevich who teamed up in 1939 to form the MiG design bureau or Pavel Sukhoi who, in the same year, set up the Sukhoi Design Bureau. We have another model wherein the single designer or design bureau concept is replaced by embedding the design aspects into the corporate structure of the manufacturer either within the prime integrators or in specialised companies like engine makers. Thus, the nomenclature of the product stems from either the name of the manufacturer, or specific names given to the product by the company. So we have engines from Rolls-Royce or GE, or SNECMA and aircraft called Mirage, Hawk, F-16, etc. Such manufacturers, who need to constantly upgrade and push their products in the front lines, have to abandon the idea of producing large numbers of products of the same design and are reluctant to 'freeze' any one basic design.

Set against the building blocks identified above, one can test the current policy parameters to see whether they match up or are deficient. Certain crucial points emerge. These are:

- A misunderstanding of the nature of defence material and industry leading to adoption of a wrong template for defence procurement. The adoption of the standard procedures for civil procurement, which are characterised by multiple demands by governments and individuals of a large number of products in varying quantities and met by many manufacturers competing in the open market, as a result of multiple contracts of short duration, has completely thwarted all attempts at building up of a viable defence industry. **There is improper appreciation by industry that because of high costs batch orders and low quantities, not many major systems integrators can expect to have viable revenue streams.**
- Equipment, which requires long-term commitments for repair, overhaul, spares, and upgrades is sourced through multiple short-term contracts, requiring repeated negotiations from different suppliers. This is to satisfy the requirement for transparency and price discovery through competition. Not surprisingly, India has one of the most diverse inventories amongst all the major military powers. Our airborne inventory has been sourced from Russia, the UK, France, the US, Italy, Israel and Brazil. Our sea-faring inventory is also from Russia, the UK, Germany, France, the US, and Israel. We also have products from many other countries, including South Africa, Holland, Finland, Switzerland, Ukraine, Sweden and many others. What this entails in terms of inventory carrying costs, repair infrastructure, and training facilities, is anybody's guess. The same mindset has resulted in even the OFB and DPSUs not building up a manageable vendor base.
- A viable R&D infrastructure has not been built up in which the entire intellectual expertise of the nation could be harnessed, with a proper review mechanism of on-going projects.
- There is improper appreciation by industry that because of high costs batch orders and low quantities, not many major systems integrators can expect to have viable revenue streams. Studies done by Maruti in the automotive sector, where assembly line production of a large number

of cars is the norm, has indicated that in the incubation stage, costs tend to be high and these stabilise after the process has been mastered. This is more so in high technology defence products where knowhow needs to be developed through indigenous efforts in the first place. Thus, it is surprising to witness that a large number of companies are applying for licences for a number of items. Obviously, since they do not have the knowhow, they are tying up with foreign collaborators, not always an easy task considering that there are very few manufacturers worldwide. All this not on the basis of firm orders but merely in the hope that competitive bids will fetch them some business.

- There is very little government support and sharing of common facilities. Long-term acquisition plans, along with technical specifications of equipment are not shared early enough for industries to take investment decisions. This is in marked contrast to the hand-holding pattern adopted elsewhere, with the resources of government departments made available for the asking.
- There is little integration between the Production and Acquisition Wings of the MoD. The acquisition executive still treats contracting and monitoring of contracts as the core activity. This may work in one-off contracts but is not the best methodology for the development of a fledgling industry. There is little flexibility in contract administration modelled on the civil template. The Production Wing has yet to develop procedures which will respond to the requirements of a wide range of producers. This is an important factor for MSMEs which have special requirements and are crucial as a support system. Similarly, start-ups and innovative projects require tailor-made procedures which need to be articulated and publicised.

Thus, the need of the hour is to address the deficiencies and to use the building blocks in order to bring about a major reconfiguration of procurement procedures; to do a systematic categorisation of the industry to cater to specific needs; and to revamp the structure of the procurement executive. Such a holistic exercise alone will clear up the clutter and provide

the highway towards greater productivity and self-reliance. It is time to show the path and, for the purpose, attention is drawn to the diagrammatic representation given earlier which has been suggested by the expert committee.

The way forward:

*Jettison the Civil Procurement Template*

The overarching recommendation of the committee is to jettison the civil procurement template as it is totally unsuitable for defence procurement. Most advanced defence manufacturing countries have adopted a different path and it is inconceivable that India can make any headway without doing so likewise. The strength of civil procurement procedures lies in its transparency which provides a level playing field to all contestants. It also provides a credible mechanism for price discovery through the operation of market forces. If an alternate mechanism has to be introduced, it must be able to satisfy the basic requirements of any procurement system. Since market forces do not apply in a monopsony, where a few suppliers are in the reckoning, the price needs to be determined by other means. This can be done through a rigorous cost audit based on mutual understanding between the buyer and seller, the methodology having been spelt out in long-term covenants entered into by the parties. This, of course, leaves the question of initial selection of the seller still open. How does one go through the selection process?

*Compile a Snapshot of Existing Indigenous Capabilities*

If “Make in India” has to succeed, all resources need to be engaged. Capabilities may exist across a wide spectrum, from basic repair and maintenance skills rising to system integration and design capabilities. As the industry moves up the capability ladder, Intellectual Property Rights (IPRs) of varying levels are generated. The decision to “Buy (Global)” or to “Make in India” would depend on the results of this survey. It would enable Indian industry to participate proportionately in various programmes, based on capabilities and potential. A benchmark of indigenous content

**The public sector would be the natural choice because of its long standing association with these segments. The private industry would provide one more player in each unit of the six segments which the committee has identified.**

will be determined, which would be gradually enhanced.

#### *Categorisation of Capabilities*

The result of this survey would lead to categorisation of industry. Those at the apex of the pyramid would have the potential to engage in construction of major platforms; smart weapons; command and control networks and complex materials. Thus, manufacture of aircraft (both fixed and rotary wings) and engines; capital ships (including aircraft carriers and submarines), armoured fighting vehicles; surface-to-surface, air-to-air, etc. guided weapons; laying down Command, Control, Communication, Computers, Intelligence, Surveillance, Targeting, Reconnaissance (C4ISTR) networks, and manufacturing critical materials like titanium and magnesium alloys would be the preserve of 'strategic partners' i.e. the industry chosen to work with the government and the armed forces on a long-term basis. The public sector would be the natural choice because of its long standing association with these segments. The private industry would provide one more player in each unit of the six segments which the committee has identified. These industries, in turn, would be supported by a larger number of smaller ones that would be chosen on the basis of the competitive model but thereafter would enter into long-term 'development partnership' relations with the prime integrators. They will specialise in quality critical equipment and will be supported in this role by the strategic partners. Such developments are already underway and we have a number of Indian industries tying up with global manufacturers as part of their supply chains. In the aerospace industry, linkages with Airbus, Lockheed Martin, Sikorsky, Ruag Aviation, Pilatus Aircraft, and Boeing have already been established. This is leading to upgradation of skills. Thus, a fledgling industry of 'development partners' is already underway. Considering the vast array of items required, there will be enough scope for the remaining industries to compete in the supply of goods

and services to the industries at the higher levels in the chain. There would be scope in the future to graduate from one level to the other. The Strategic Partners (SPs) would be required to collaborate with FOEMs, willing to share knowhow. The choice of the FOEM as that of the SPs would be that of the government acting in tandem with the armed forces.

#### *Choosing the Strategic Partners*

Having done the general categorisation, the next step would be the choice of the SP. A robust, transparent procedure needs to be put in place wherein existing industries can compete. Obviously, the parameters on the basis of which such a competition can be held need to be developed in the absence of commercial bids based on the cost of the product, which are not feasible as none amongst Indian industry has the product. The parameters can be categorised as financial, managerial; human resources, including worker skills; production capabilities; and familiarity with industrial processes, etc. Assessment will be done on the basis of these parameters, in conjunction with field visits to facilities and meetings with management to assess their commitment to work with the government. Such parameters would need to have legal acceptance.

#### *Some Questions Answered*

Questions may arise as to whether monopolies are being created by such long-term arrangements. Apart from the fact that a public sector entity would always be a countervailing force, the space, as has already been analysed, has little scope for many players and it would not be in the national interest to give false hope that economic order quantities would be forthcoming to a number of manufacturers for all of them to have sustained profit streams. Similarly, even limited commercial bids, after short-listing, need to be avoided as the temptation to be selected as an SP can encourage predatory unviable bids.

**Considering the vast array of items required, there will be enough scope for the remaining industries to compete in the supply of goods and services to the industries at the higher levels in the chain.**

***Building a Conducive Atmosphere to Encourage R&D, and Innovation;  
Resource Sharing and Constant Government Support***

Without these elements, a viable defence industry would be difficult to establish, considering the uncertainties and costs involved. Rigidity in procedures and unwillingness to go beyond the written word can prove disastrous.

***Establishment of a Broad-Based Procurement Executive***

Such an administrative arrangement only can ensure that the wings within departments do not work at cross-purposes and no critical organisation is left out. Collaboration and not antagonism should be the guiding principles. The tendency to work in water-tight silos would need to be abandoned and seamless integration forged within various departments and with industries. It follows that the Production and Acquisition Wings would have to be integrated within the same executive. This executive would have representations of industry, as also the Quality Assurance and Standardisation Directorates embedded within it. It should have facilitation desks for new aspirants and provide a virtual clearance house for information exchange. There should be seeker teams proactively scanning the industrial landscape to identify innovative ideas and companies and devising tailor-made funding mechanisms, especially for MSMEs. Management of production and acquisition needs to be recognised as a discipline, with periodic upgradation of skills of the personnel involved.

***MoD Must Solicit Support of Other Departments***

The MoD must seek the willing support of other departments and institutions in the matter of tax policy; funding arrangements; skill development; involvement of academic institutions; foreign direct investment and exports. Consultative arrangements need to be put in place.

It is felt that such a restructuring of the defence establishment needs to be done to remove the clutter and to channel efforts in a purposeful direction. Such a paradigm shift in policy, which is long overdue, alone can lead to greater self-reliance and convert India into a true military power.

## EXECUTIVE SUMMARY

Just as in the case of scientific research and technological innovation, it is essential to clearly establish the fundamentals, so too it is in the case of policy formulation. Lack of clarity in the fundamentals can lead to sub-optimal policies, making it difficult to achieve the desired results. The production and acquisition policy for armaments in India has suffered because of this lacuna which has resulted in India still relying heavily on arms imports to further its national security goals despite many years of efforts to produce armaments indigenously. Excessive reliance on the public sector and repeated recourse to ToT from foreign equipment manufacturers has brought in complacency, and little effort towards local R&D. Similarly, adoption of the civil template for procurement of defence material, which differs widely in configuration and technological content from civil products, has led to many undesirable results. The current scenario, wherein FOEMs, the public sector, and Indian private industry (which, in turn, ranges from large producers of civil products to MSMEs) are all vying for pieces of the same pie, needs to be de-cluttered and categorised, so that the strengths of each are properly assessed and utilised. This would require jettisoning of the civil procurement template, recognition of the distinctive features of defence material, an understanding of the defence industry as it has evolved elsewhere, and the constitution of a multi-disciplinary procurement executive to handle matters of defence production and acquisition in an integrated manner.

## READINGS

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# INDIAN MILITARY NUCLEAR PROGRAMME: TRAJECTORY AND FUTURE COURSE

**ARJUN SUBRAMANIAN P**

India started off with a peaceful nuclear programme. However, geo-political compulsions and the reality of international politics forced it to acquire nuclear weapons capability. India suffered a military defeat in a war forced upon it by China by illegally occupying a chunk of territory in Jammu and Kashmir (J&K). Less than two years later, China conducted its first nuclear test and was actively pursuing ballistic missile development programme. By 1966, China, for the first time, acquired a deliverable nuclear warhead that could be fitted on a ballistic missile. The Indian military nuclear programme was kick-started during this period. At present, India has advanced nuclear weapons capability that meets the requirements of the current threat scenario.

This article studies the Indian nuclear programme from the material perspective. India's route to nuclear weapons capability and the material factors that influenced it are discussed. Also, the external influencing factors – China and Pakistan and the recent attempt by Pakistan to lower the nuclear threshold to the tactical level—are looked at and its impact and efficiency are analysed. India's future nuclear weapons producing capacity to meet its future nuclear deterrence requirement is also analysed.

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**Research reactors like this, with very low burn up rate and which use (mostly) heavy water or graphite for moderation are the ideal type of reactors to produce weapon grade plutonium.**

#### **INDIAN NUCLEAR WEAPONS PROGRAMME**

From the start, India's nuclear weapons programme has been based on plutonium (Pu) fuel. All the tests, including the 1974 Peaceful Nuclear Test (PNE), used Pu-239. A few factors may have contributed to the selection of plutonium over Highly Enriched Uranium (HEU). Firstly, India was operating a Canadian supplied heavy water moderated research reactor, which produces plutonium as a by-product. This plutonium can then be extracted

and processed to obtain weapon grade plutonium. Secondly, plutonium has certain advantages over uranium like lower fuel requirement for a particular yield. Further, India probably started off with a peaceful nuclear programme, with the intention to just demonstrate its nuclear weapon capability. The device that was tested in 1974 was not of a weaponisable configuration.

#### **PEACEFUL NUCLEAR EXPLOSION (PNE)**

The Indian nuclear weapon programme sprang from its civilian nuclear programme. India developed what is called the CIRUS research reactor with Canadian assistance while the moderator (heavy water) was supplied by the United States.<sup>1</sup> It is a tank type reactor of 40 MW(t) capacity which uses natural uranium as fuel, heavy water as moderator, light water as coolant, B<sub>4</sub>C filled rods for control and has a neutron flux of  $6.5 \times 10^{13}$  (n/cm<sup>2</sup>/s).<sup>2</sup> Research reactors like this, with very low burn up rate and which use (mostly) heavy water or graphite for moderation are the ideal type of reactors to produce weapon grade plutonium. One other advantage is that such a reactor can be refuelled when it is online. Another option with this type of reactor is that target elements can be introduced while online

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1. "Canadian-Indian Reactor, U.S", <http://www.nti.org/facilities/832/>, September 1, 2003.
  2. D.K Shukla, "Safety Management and Effective Utilisation of Indian Research Reactors APSARA, CIRUS and DHARVA", [http://www-pub.iaea.org/mtcd/publications/pdf/p1360\\_icrr\\_2007\\_cd/papers/d.k.%20shukla.pdf](http://www-pub.iaea.org/mtcd/publications/pdf/p1360_icrr_2007_cd/papers/d.k.%20shukla.pdf), 2007.

where depleted or U-238 can be introduced for irradiation for a limited period which results in the production of fissile Pu-239. Probably, this was not done for India's PNE. The reactor is capable of producing 6.6 to 10.5 kg of plutonium a year at a capacity factor of 50 to 80 percent respectively.<sup>3</sup> However, the spent fuel from the reactor was reprocessed to obtain the fuel for the 1974 explosion.

Work for the 1974 PNE actually began in 1964 when Prime Minister Lal Bahadur Shastri authorised the theoretical and technical ground work. Despite the prime minister being averse to weaponising India's nuclear capability, he had authorised the technical work to begin.<sup>4</sup> It is said that the Indian nuclear scientific community was desperate to demonstrate its capability, but the bigger push might have come from the first Chinese nuclear test a month earlier. Certainly, the Chinese test would have had a major influence on India's decision to go for nuclear testing as India had suffered its worst military defeat in the 1962 War which was a result of the illegal Chinese occupation of Indian territory. Some parliamentarians too were of the opinion that India should weaponise its nuclear capability as a deterrent to China.

India is not the only country to have conducted a PNE—the United States and Russia have conducted multiple PNE tests for various experimentations like civil engineering purposes, etc. The USA had conducted around 150 PNEs from 1957-75.<sup>5</sup> Hence, India was justified in conducting its own peaceful nuclear explosion. Further, the agreement with the USA and Canada stipulated that the fuel from the reactor be used only for peaceful purposes. India did conform to the agreement

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3. "India's Nuclear Weapons Program: Present Capabilities". <http://nuclearweaponarchive.org/India/IndiaArsenal.html>, April 5, 2001.

4. "Nuclear", <http://www.nti.org/country-profiles/india/nuclear/>, August 2015.

5. "Peaceful Nuclear Explosions", <http://www.world-nuclear.org/info/Non-Power-Nuclear-Applications/Industry/Peaceful-Nuclear-Explosions/>, July 2010.

as it was a peaceful explosion, as declared, and was not optimised for weaponising.

The PNE is claimed to have a yield of around 12 to 15 kilotonnes (kt), which is roughly the yield of the bomb dropped on Hiroshima, the only difference being that the design was not a weaponisable configuration, possibly being a less sophisticated assembly of fuel material, with a little excess of plutonium for the desired yield, less amount of high explosive, and less efficient tampering. In fact, the weapon was less sophisticated, considering the possible amount of fuel used and other devices like High Explosive (HE) lenses as the trigger. The bomb was of the implosion type, the kind that was dropped on Nagasaki, however, the yield of the Indian bomb (12-15kt) was lower than that of Fat Man (20-22kt). Fat Man used around 6.2 kg of plutonium to produce the given yield, while the Indian bomb could have used the same amount of plutonium or a little more (this is determined by the quality of the plutonium core and the efficiency of the bomb design, like tampering, etc.), given that it used just 12 fast-slow HE lenses, where each lens weighed 100 kg,<sup>6</sup> which amounts to a total lens mass of 1,200 kg. Whereas the Fat Man design (the Indian bomb appears to be more or less based on the Fat Man design, given that the fast and slow explosive material design as well as the type of HE material used in the device was similar<sup>7</sup> – the only exception was that the structure of the lenses was different) and used a 32 lens soccer ball structure where each weighed 63 kg (hexagonal) and 43 kg (pentagonal) with a total lens weight of 1,836 kg.<sup>8</sup> This is one reason why Fat Man had a higher yield compared to the Indian device. Further, the detonators are claimed to be lead azide spark gap detonators which are less sophisticated than the Exploding Bridge Wire (EBW) design.<sup>9</sup>

Despite all the preparations for the test going on for years, it caught the world by surprise, including the United States. Only the US State

6. "India's Nuclear Weapons Program: Smiling Buddha: 1974", <http://nuclearweaponarchive.org/India/IndiaSmiling.html>, November 8, 2001.

7. Ibid.

8. "The First Nuclear Weapons", <http://nuclearweaponarchive.org/Nwfaq/Nfaq8.html>, July 3, 2007.

9. n.6 .

Department's Bureau of Intelligence and Research (INR) raised any suspicion about India testing a nuclear device. However, the probability of the Indian political establishment authorising such a test was believed to be low at the time.<sup>10</sup> This was known from the later declassified US Embassy-India cables.<sup>11</sup> One other geo-political factor that may have been an immediate trigger for the authorisation of the test was the Nixon Administration's opening up of friendly relations with China, with President Nixon's visit to China in early 1972. With the warming of ties between the US and China, any hope of US assistance to India in case of aggression by China would have faded.<sup>12</sup> In addition to this, the *Enterprise* incident during the 1971 War clearly pointed to the hostile nature of US policies against India. This clearly put India in an unfavourable situation as far as China was concerned. These scenarios may have pushed India to build nuclear capability for self-defence. Hence, all the factors, including the effects of the non-alignment policy and the geo-political scenario of the time played a role in making India demonstrate nuclear weapons capability to build deterrence capability against its northern neighbour.

### **ROLE OF THE PURNIMA-I REACTOR IN THE 1974 PNE**

As fuel for the bomb was a problem then, some separated plutonium from the CIRUS reactor, about 18 kg, was used in the indigenously built research plutonium reactor for the Neutron Investigation in Multiplying Assemblies (PURNIMA)-I.<sup>13</sup> It was planned that the fuel for the bomb would come from the PHOENIX plutonium separation plant in Trombay. However, the plant suffered a leak and was shut down in 1970; the hopes of restarting the plant quickly faded by late 1972, and PURNIMA was using the separated plutonium from CIRUS. It was then that the decision was taken to shut down and dismantle PURNIMA-I to divert its fuel for bomb making. In early 1973,

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10. "The Nixon Administration and the Indian Nuclear Program, 1972-1974", *National Security Archive Electronic Briefing Book*, No. 367, December 5, 2011, Available at: <http://nsarchive.gwu.edu/nukevault/ebb367/>

11. Ibid.

12. Ibid.

13. Taraknath V.K Woodi, William S Charlton, Paul Nelson, *India's Nuclear Fuel Cycle: Unraveling the Impact of the U.S-India Nuclear Accord* (Morgan and Claypool Publishers), Ch. 2, p.9.

the reactor was shut down and the fuel was later utilised in the 1974 PNE.<sup>14</sup> Apart from this, PURNIMA-I helped Indian nuclear scientists to study and experiment with weapon fission characteristics. Indian scientists visiting the Soviet Union in the late 1960s were impressed with the plutonium fuelled, pulsed fast reactor which could be used for studying the fission bomb. This was the same type of reactor used during the Manhattan Project to perform the “tickling the dragon’s tail” experiments. The Indian Atomic Energy Commission (AEC) approved the building of PURNIMA-1 in 1969 and the reactor attained criticality in May 1972. As a pulsed fast reactor, PURNIMA-I operated on much the same principles as a rudimentary fission bomb. This gave the Bhabha Atomic Research Centre (BARC) scientists benchmark calculations on the behaviour of a chain-reacting plutonium system and the kinetic behaviour of the system just above criticality. These calculations were used to determine the optimum explosive power and the neutron trigger of future bombs.<sup>15</sup> Apart from this reactor, by 1964, India had a large number of specialists working on plutonium metallurgy, who would have been immensely valuable in making the fuel core design for the bomb.<sup>16</sup> The plutonium core for the bomb was fabricated by a team led by PR Roy of BARC’s radio-metallurgy department, who had also made the plutonium fuel rods for PURNIMA.<sup>17</sup>

### **THE 1998 UNDERGROUND TEST: WEAPONISATION**

India finally went nuclear in 1998 when it tested five weaponisable nuclear devices in May that year. The tests were in the planning stage for several years which, however, got postponed due to some reasons each time. The last attempt before the May tests was during the 13 days when the Bharatiya Janata Party (BJP) was in power. It is said that the weapons were actually placed in the shafts, ready to be tested. However, the plan was aborted when it became clear that the government would not survive the vote of

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14. n.6 .

15. “Purnima I-II-III”, <http://www.nti.org/facilities/861/>, September 1, 2003.

16. George Percovich, *India’s Nuclear Bomb: The Impact on Global Proliferation* (University of California Press, 2001), Ch. 2, p.71.

17. n.6 .

confidence which would prevent the administration from effectively dealing with the aftermath of the tests.<sup>18</sup> The 1998 tests involved five devices—one thermonuclear and the rest were fission devices. Among the fission devices, one was a 12-15 kt yield fission device and the rest were sub-kilotonne weapons. The tests were conducted in two phases: the first set was on May 11 when three devices were fired simultaneously with one being the 45 kt thermonuclear device, the second being the 12-15 kt fission bomb and the third, the sub-kilotonne device. The firing of the other two sub-kilotonne devices was done on May 13.

### **WHY SUB-KILOTONNE? A POINTER TO TACTICAL NUCLEAR WEAPON**

The idea behind the sub-kilotonne weapons tests is not understood. Neither is it known if the design was weaponised. Going by the fuel, which was plutonium, the size of the core would have been comparatively small. Even the most conservative guess would make it a 2 or 3 kg one, which again depends on the design efficiency of the weapon. Details available on the public domain indicate that around 3 kg of plutonium might have been used. According to Chengappa, the plutonium for the devices weighed 3 to 8 kg.<sup>19</sup> If the design efficiency is high, the amount of fuel would be low, resulting in reduced size of the fuel core. Further reduction in the size of the weapon depends on the geometry of the high explosive lenses and the other triggering mechanisms. Now, the question arises, did the Indian government or at least did the scientific community involved in the test, have tactical nuclear weapons in mind? (Here, the term tactical is used in relation to the yield of the weapon.) Apart from the yield, the size and weight [which determine the carrier vehicle (for a tactical role)] of the nuclear weapon can also be questioned, given that the only missile delivery vehicle at that time was the Prithvi. If the lowest amount of plutonium used was indeed 3 kg in the 1998 test, then it is possible that the size and weight of the low yield design would have been heavier than a specifically built

18. "India's Nuclear Weapons Program: Operation Shakti: 1998", <http://nuclearweaponarchive.org/India/IndiaShakti.html>, March 30, 2001.

19. Ibid.

**This idea of proportional retaliation emerged only after Pakistan tested its tactical nuclear delivery vehicle and lowered the nuclear threshold to the tactical level.**

tactical nuclear device (considering the Cold War tactical nuclear weapon designs).

Certainly, there are some sections within the Indian strategic community who vouch for proportional retaliation if Pakistan were to ever use tactical nuclear against Indian forces, either in India or outside Indian soil, which is in contrast to the official nuclear doctrine that any use of nuclear weapons against India, irrespective of the yield will be considered as a first strike and will be responded with retaliation that will be massive and unacceptable. This idea of proportional retaliation emerged only after Pakistan tested its tactical nuclear delivery vehicle and lowered the nuclear threshold to the tactical level. However, till date, it is not known if Pakistan is building the tactical nuclear weapon that is compact enough to be delivered using the Nasr ballistic missile. The feasibility of Pakistan acquiring tactical nuclear weapon capability will be assessed later in this article.

#### **SIZE OF INDIAN NUCLEAR ARSENAL**

Estimates available in the public domain on the number of nuclear weapons in the Indian arsenal are of between 80 to 120 warheads. *The Bulletin of Atomic Scientists*, published in 2012, estimates that the Indian nuclear forces have approximately 520 kg of weapon grade plutonium, sufficient for around 100 to 130 weapons. The *Bulletin* also believes that India has not weaponised all of its plutonium stockpiles—just 80-100 weapons.<sup>20</sup> However, the yield distribution of the Indian arsenal is not known i.e India tested five devices of various yields in weaponisable configuration, but the deployment distribution of these designs is not known. The distribution and the actual number could throw light on India's nuclear threat perception and its minimum deterrence estimation. However, when it comes to the number of

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20. Hans M. Kristensen, Robert Norris, "Indian Nuclear Arsenal 2012", *Indian Nuclear Forces 2012, Bulletin of the Atomic Scientists*, May 30, 2013.

nuclear weapons needed, it might not strictly be restricted to the threat perception, and there are other factors too that might play a role in the numbers game. For example, India has just begun to diversify its nuclear strike vectors (platforms) by establishing the third leg of deterrence. Assuming that India had already met its minimum deterrence requirement on land, the sea vector would lead to further build-up of weapons that have to be deployed in the SSBNs (Strategic Submarine Ballistic Nuclear).

The present status of the Indian sea-based deterrent is the INS *Arihant* SSBN with the Sagarika (K-15 or B05) Submarine Launched Ballistic Missiles (SLBM). The *Arihant* design has four launch tubes which can carry three Sagarika missiles each. Some shortcomings regarding operational constraints due to the design and range of the missiles might force India to opt for a better and bigger design, with a greater number of launch tubes and longer range missiles like the K-4, which is under development. Further, India would increase the number of SSBNs it deploys at sea. This might push up the number of nuclear weapons required. It is to be noted that nuclear weapons deployed in an SSBN would be in a ready to fire state (yet with all the checks and safety measures in place), with the weapon mated to the missile.

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### THREAT PERCEPTION

Certainly, the improving Chinese nuclear strike capability which is already way ahead of India's does loom large in the Indian threat perception. China has an active ballistic missile development programme. While the Indian nuclear weapons' highest yield tested was 45 kt [Shakti-I (1998) thermo nuclear device], it was claimed by senior Indian nuclear scientists that the yield of the weapon could be raised to 200 kt, if required, without further testing. The others were all fission devices with just one with comparatively

higher yield (13 to 15 kt), and the rest, sub-kilotonne yield. In comparison, China has a larger arsenal as well as weapons with far higher yield. The highest yield weapons with China are 3 and 4 megatonnes (Mt). Combined with highly accurate (some variants have terminal guidance) long range ballistic missiles, their nuclear strike and precise calculated damage causing capability is quite advanced. Since India had declared a unilateral moratorium on nuclear testing, it is not likely to develop high yield weapons of the order of megatonnes yield. Yet, logically speaking, India should opt for deploying a higher number of nuclear weapons to compensate for the reduced yield.

As far as Pakistan is concerned, India appears to have a comparative edge in nuclear weapons and delivery capability. The Pakistani nuclear weapons' yield is more or less equivalent to India's fission devices<sup>21</sup> except for the absence of thermonuclear weapons. However, Pakistan's weapons capability is primarily being used by it like a fence against an Indian punitive retaliatory conventional strike. With India believed to have come up with the new conventional battle doctrine to fight a limited but high intense short duration war to keep it under the nuclear threshold (as believed), which defeats Pakistan's idea, Pakistan has attempted to lower the nuclear threshold. Pakistan had tested what it calls the tactical nuclear delivery vehicle called the Nasr which has a range of 60 km.<sup>22</sup> The purpose of this ballistic missile nuclear weapons delivery vehicle would be to strike Indian conventional forces advancing into Pakistan's territory in times of war. India responded by stating again categorically that any nuclear strike (a generalised term which conveys that India does not differentiate between a tactical and a strategic nuclear strike ) in its territory or its forces anywhere else would be considered as a first strike and would be met with a massive and unacceptable retaliatory nuclear strike.

However, there might be considerable worry as these tactical nuclear weapons, owing to the kind of command and control set-up they would necessitate and given the radicalism and terrorism in Pakistan, if actually

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21. "Pakistan Nuclear Weapons", <http://fas.org/nuke/guide/pakistan/nuke/>

22. "Tactical Ballistic Missile", <http://www.military-today.com/missiles/nasr.htm>

used, which would result in a nuclear crisis of unimaginable magnitude. But before contemplating such a scenario, it needs to be looked at whether Pakistan will be able to design and develop a tactical nuclear weapon small enough to be fitted into the Nasr. Further, how effective such a tactical nuclear strike would be in stopping Indian conventional forces. The following paragraphs would briefly look at such factors.

### **LOWERING THE THRESHOLD: PAKISTAN'S TACTICAL NUCLEAR PROGRAMME**

As far as the intentions are concerned, it appears Pakistan is serious about its tactical nuclear weapons capability. In the month of October 2015, Pakistani Foreign Secretary Aizaz Chaudhry stated that Pakistan has developed low yield nuclear weapons to deal with India's so-called Cold Start conventional military doctrine. This was the first time that a senior Pakistani official has given an explanation on the country's decision to build tactical nuclear weapons.<sup>23</sup> However, despite the statement, it is not clear if the tactical nuclear weapons he mentioned are new designs, using plutonium fuel, small enough to arm the Nasr ballistic missile. It is to be noted that Pakistan, in its nuclear tests in 1998, in response to the Indian tests the same year, had tested some uranium fuelled sub-kilotonne weapons too. It is possible that he was referring to those sub-kilotonne weapons which could be used tactically with Pakistan's existing Short Range Ballistic Missiles (SRBMs) or nuclear strike aircraft. Nevertheless, if indeed the foreign secretary was referring to a new tactical nuclear weapon, small enough to be delivered by the Nasr, then it is an indication that the weapon will be plutonium fuelled, obtained from Pakistani plutonium production facilities.

### **PAKISTAN'S WEAPON GRADE PLUTONIUM PRODUCTION CAPACITY**

Pakistan's primary weapon-grade plutonium production facility is the Khushab nuclear complex in Punjab province. There are four nuclear reactors

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23. "Pakistan Develops Nuclear Weapons to Combat Possible War with India", <http://www.defencenews.in/defence-news-internal.aspx?id=L8A0E08WCF8=> , October 20, 2015.

**The Nuclear Threat Initiative (NTI) estimates that all the four reactors can together produce 24-48 kg of weapon grade plutonium. This would be sufficient to produce around 10 nuclear weapons. The Khushab facility has a heavy water production facility as well.**

capable of producing plutonium which can be used to produce nuclear weapons after processing. These reactors use heavy water as moderator and natural uranium as fuel. Heavy water moderated reactors are suitable for producing plutonium which can be processed to extract weapons grade plutonium. The fourth reactor is believed to have been operationalised recently. The confirmation was based on satellite imagery.<sup>24</sup> The Institute for Science and International Security (ISIS) estimates the thermal capacity of the reactor to be 50 MW (t), while the capacity of the first three reactors, as estimated, is 40-50 MW(t).<sup>25</sup>

The Nuclear Threat Initiative (NTI) estimates that all the four reactors can together produce 24-48 kg of weapon grade plutonium.<sup>26</sup> This would be sufficient to produce around 10 nuclear weapons. The Khushab facility has a heavy water production facility as well.

The other facility in Chashma is being built with Chinese assistance (the reactor is an indigenous Chinese Qinshan 1 reactor design). Two of the four reactors in this facility are still under construction at the time of writing this article. These reactors are not of much concern regarding weapon grade plutonium production as these are pressurised water reactors using light water as coolant and moderator. Hence, such reactors are not suitable for a weapons programme.

When it comes to designing a bomb with plutonium, it would not be a major hurdle for Pakistan as its HEU fuelled warhead is based on the implosion design.<sup>27</sup> Plutonium fuelled bombs would necessitate an implosion design. However, plutonium-based implosion devices are

24. "Pakistan's Fourth Nuclear Reactor at Khushab Now Appears Operational", <http://timesofindia.indiatimes.com/world/pakistan/Pakistans-fourth-nuclear-reactor-at-Khushab-now-appears-operational/articleshow/45919653.cms>, January 17, 2015.

25. "Khushab Complex", <http://www.nti.org/facilities/940/>, December 13, 2013.

26. Ibid.

27. "Pakistan's Nuclear Weapons", <http://fas.org/nuke/guide/pakistan/nuke/>

complex compared to HEU fuelled weapons. Plutonium handling, temperature maintenance inside the warhead and taking care to prevent premature initiations from loose neutrons from the other plutonium isotope, are some of the complexities, but for a state like Pakistan these would be minor hurdles.

The question of miniaturisation of the bomb would be quite feasible and that is the exact reason why Pakistan has opted for producing weapons grade plutonium. The United States and the Soviet Union have tactical nuclear weapons. A Cold War news report—some believe it to be a rumour—claims that the Soviet KGB has suitcase nuclear bombs i.e. a nuclear bomb small enough to be fitted in a suitcase, which can be carried around.<sup>28</sup> Further, the US had what is known as the Davy Crockett field level nuclear weapon that could be fired using a recoilless sort of weapon operated by a two-man crew. The weapon (W54) weighed just 76 pounds, and had a length of 79 cm and a diameter of 28 cm.<sup>29</sup> There are other tactical nuclear weapons with higher yields, in some cases around 10 kt, that could fit into the Nasr payload section.<sup>30</sup> Hence, miniaturisation, though complex by design, is quite possible to achieve by a state like Pakistan which can muster sufficient resources.

One important question is, how much damage can it bring to the Indian armoured formations that would be thrust into Pakistan? Will the tactical nuclear weapons be able to stop an Indian armoured advance? An armoured column is considered here because that would form the main strike element which will be combined with mechanised infantry. The Indian government

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28. "Congressman Weldon Fears Soviets Hid A-Bombs Across US", <http://www.nti.org/analysis/articles/congressman-weldon-fears-soviets-hid-bombs-across-us/>, October 26, 1999.

29. Alan Bellows, "Davy Crockett: King of the Atomic Frontier", <http://www.damninteresting.com/davy-crockett-king-of-the-atomic-frontier/>,

30. National Institute of Advanced Studies, Bangalore, had done a detailed analysis on this subject including dimensions of the Nasr. Available here: [http://issp.in/wp-content/uploads/2013/07/R17-2013\\_NASR\\_Final.pdf](http://issp.in/wp-content/uploads/2013/07/R17-2013_NASR_Final.pdf)

and the armed forces have denied the term 'Cold Start'. Comments have come up regarding a strategy called 'Proactive Strategy' which is basically an idea for faster mobilisation for bringing in the element of surprise on the enemy, and for quicker attainment of the objective, and to keep the conflict below the nuclear threshold. Such objectives would anyway require a motorised advance which would be the armoured columns, supported by motorised infantry.

Coming to the effects and the utility of such tactical nuclear weapons on advancing armoured columns, it is pertinent to look at the weapon effects. One variant of the W54 had a yield of 0.2 to 1 kt. Now, the yield of the Pakistani tactical nuclear weapons is not known. Aiziz Chaudhary had termed it as a low-yield nuclear weapon and not a sub-kilotonne nuclear weapon. However, a sub-kilotonne weapon would still fall under low yield. For Pakistan to have a miniaturised warhead with yield above 2 kt, the design efficiency would have to be very high, with highly effective tampering around the core, while still achieving a weight within the payload limit. In some cases, beryllium which is an efficient neutron reflector is used for the purpose of providing tampering. Even if the yield is more than 1 kt, it would not be sufficient (considering the blast effects alone) to stop an Indian advance. AH Nayyar and Zia Mian have done a detailed analysis on the subject in their paper "The Limited Military Utility of Pakistan's Battlefield use of Nuclear Weapons in Response to a Large-Scale Indian Conventional Attack".<sup>31</sup> The conclusion of their study states that the tactical nuclear weapons would not be effective in stopping an Indian armoured advance. Even if they are designed for enhanced radiation effects, like the US' Davis Crockett, they would not be sufficient to stop an Indian advance. However, they might slow it down as some of the infantry would be affected by the high radiation dose. But this slowdown might not be significant enough to have any major impact on the operations.

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31. AH Nayyar and Zia Mian, *The Limited Military Utility of Pakistan's Battlefield use of Nuclear Weapons in Response to Large Scale Indian Conventional Attack* (Pakistan Security Research Unit, University of Bradford , November 11, 2010).

The Indian nuclear doctrine, as explained above, does not differentiate between a tactical and a strategic nuclear strike, be it within Indian territory or on Indian personnel outside its borders. India would go for massive and unacceptable nuclear retaliation if ever attacked with nuclear weapons. In this scenario, wherein Pakistan's tactical nuclear force would not serve its intended purpose and would meet with massive Indian retaliation, it would make no sense for Pakistan to deploy these so-called tactical nuclear weapons.

### **INDIAN NUCLEAR TRAJECTORY**

Given the threat scenario, India has a reasonably good arsenal to deter any nuclear eventuality with Pakistan. Pakistan's tactical nuclear weapons production would not affect the Indian nuclear deterrence capability much. However, India could improve the accuracy of its missile delivery systems for better targeting efficiency. With respect to China, India may have to increase the number of delivery vehicles capable of reaching the eastern seaboard of the People's Republic of China (PRC) which comprises most of its economic hub. Further, India having declared a unilateral moratorium on nuclear testing, might have to increase its nuclear weapons arsenal, not to match China's but to affect better deterrence with it, given the bigger size of China's vital cities and the number of such potential targets in its eastern and southeastern parts.

### **INDIAN WEAPON GRADE PLUTONIUM PRODUCTION CAPABILITY AND EXISTING STOCKPILE**

Some estimates put India's total weapon grade plutonium inventory between 445 to 530 kg, as of 2004. David Albright, in his paper titled "India's Military Plutonium Inventory, End 2004" had considered various factors such as the number and type of plutonium producing research reactors in India, their operating capacities (thermal) at various times, the amount of plutonium produced, and the possible amount of fuel consumed in the 1998 nuclear testing. He puts the number as of 2004, at between 445 and 530 kg. With this number, considering 4 to 7 kg of fuel per bomb, the total

**Apart from the CIRUS, BARC operates other research reactors that could produce plutonium both as a by-product and via irradiation. The biggest source of reactor grade plutonium in India is from the line of indigenous Pressurised Heavy Water Reactors (PHWRs).**

inventory would come to around to 100 weapons.<sup>32</sup> Since then, India would have produced more Weapon Grade Plutonium (WGP). In 2010, as part of the Indo-US nuclear deal, the CIRUS reactor was shut down and a year later its nuclear fuel was transferred to Trombay for reprocessing.<sup>33</sup> Apart from the CIRUS, BARC operates other research reactors that could produce plutonium both as a by-product and via irradiation. The biggest source of reactor grade plutonium in India is from the line of indigenous Pressurised Heavy Water Reactors (PHWRs). It is estimated that, as of 2006, India had accumulated about 11.5 tonnes of reactor grade plutonium from its PHWRs and it is also speculated that a major fraction of the plutonium would have been separated.<sup>34</sup> Another source for plutonium would be the India fast breeder programme. All the plutonium production reactors operational now would remain out of international safeguards.

The Prototype Fast Breeder Reactor (PFBR) has a thermal capacity of 1,250 MW and uses mixed-oxide fuel in the core and depleted UO<sub>2</sub> in the radial and axial blanket regions.<sup>35</sup> A study on Weapon Grade Plutonium (WGP) production capacity by the PFBR was undertaken by Alexander Glaser and MV Ramanna. As per their study, the PFBR would be able to produce 144 kg of WGP annually (if separate processing of the radial and axial blanket is undertaken). The reactor could also be operated in the military mode, but if more than 35 percent of the plutonium is diverted (including the processing loss), the reactor will not be self-sufficient. However, to make it

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32. David Albright, "India's Military Plutonium Inventory, End 2004", ISIS, May 7, 2005.

33. "Research Nuclear Reactor CIRUS to Shutdown Permanently on December 31", <http://www.dnaindia.com/mumbai/report-research-n-reactor-cirus-to-shutdown-permanently-on-december-31-1482987>, December 18, 2010.

34. Alexander Glaser and MV Ramana, "Weapon Grade Plutonium Production Potential in the Indian Prototype Fast Breeder Reactor", *Science and Global Security*, 2007, p.97.

35. Ibid.

sustainable, India could use the reactor grade plutonium from the PHWR to compensate for the diversion of fuel for the weapons programme.<sup>36</sup> The study also finds that if India were to successfully implement its plan to build and operate a total of five fast breeder reactors by 2020, WGP production could reach 700 kg per year. India could sustain this level of production for several decades without building additional heavy water reactors.<sup>37</sup>

## CONCLUSION

At this rate of plutonium production, India could not only sustain its three-stage civilian nuclear programme, but also cater for any future demand in increasing its nuclear stockpile. In the coming decades, the sea leg of India's deterrence could demand production of more nuclear warheads to be deployed in the SSBNs. Moreover, the targeting requirements for China might require further increase in the credible minimum requirement mark. Another compelling factor for India in the future might be the possibility of Pakistan switching over to producing plutonium fuelled weapons from the current HEU-based weapon. One advantage of this would be that plutonium fuel would be less attractive for non-state actors to build a nuclear weapon since it is design-wise more complex and also it is quite tricky to handle plutonium fuel, as an isotope releases stray neutrons that may set-off a chain reaction prematurely. Otherwise, the coming decades could see several factors primarily emanating from Pakistan and China that might influence the Indian nuclear deterrence calculus for the future.

**The PFBR would be able to produce 144 kg of WGP annually (if separate processing of the radial and axial blanket is undertaken). The reactor could also be operated in the military mode, but if more than 35 percent of the plutonium is diverted (including the processing loss), the reactor will not be self-sufficient.**

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36. Ibid., p.100.

37. Ibid., p.100.

# ROLE OF INDIA, PAKISTAN, CHINA IN AFGHANISTAN POST-US DRAWDOWN

SHALINI CHAWLA

Afghanistan is facing multiple challenges on various fronts post the US drawdown. It is difficult to trace a stable phase in Kabul's history which has had a troubled past, faces a striving present and has an uncertain future. Afghanistan experienced controversial elections in 2014, followed by a rather uniquely complicated political set-up. There is division of opinion as to how the Afghan economy will grow as it is highly dependent on foreign aid and lacks self-sufficiency. The security situation has worsened as the pull-out of the US and North Atlantic Treaty Organisation (NATO) forces has further encouraged the Taliban to intensify the terrorist operations and network.

The drawdown was completed in December 2014 but there still seems to be lack of clarity about how the state would shape and stabilise itself in the midst of the raging insurgency. The regional actors are strong and have influential roles to play in the future of Afghanistan. In this context, it is needless to say that Pakistan is the most important player and could be a potential game changer for Afghanistan. Islamabad remains wedded to the idea of maintaining "strategic depth" in Afghanistan and is deeply conscious of strengthening its footprint. India has been engaged in Afghanistan in the

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**The all powerful military and the intelligence agency, the Inter-Services Intelligence (ISI), which authored and executed the policy of strategic depth since the late 1980s through the 1990s, when it strongly backed the Taliban, till today, strongly believes in having strong control over Afghanistan.**

developmental role and enjoys soft power dominance. China is a new player, with strategic, economic and security concerns, and is increasingly engaging in Afghanistan on various fronts, including the facilitation of the peace talks.

The aim of this article is to analyse the objectives and roles of the regional actors – India, Pakistan and China – in Afghanistan post the drawdown. The three players have varied interests in Afghanistan and have adopted different approaches, not essentially coordinating with each other.

The study intends to understand India's challenges in Afghanistan as the other two powerful players (Pakistan and China) have had a strong strategic and military alliance for more than five decades.

### **PAKISTAN'S ROLE IN AFGHANISTAN: DESIRE FOR STRATEGIC DEPTH**

To understand what role Pakistan could play in Afghanistan in the future, it is essential to understand and evaluate its strategy of strategic depth. Undoubtedly, Pakistan has been overly obsessed with the desire to gain strategic depth in Afghanistan. The all powerful military and the intelligence agency, the Inter-Services Intelligence (ISI), which authored and executed the policy of strategic depth since the late 1980s through the 1990s, when it strongly backed the Taliban, till today, strongly believes in having strong control over Afghanistan. There has been a slight change in the terminology regarding the military's policy in Afghanistan, but the bottom line remains unaltered. At no stage was the policy of "strategic depth" logical or viable for Pakistan, and its adoption of this doctrine and, thus, control over Afghanistan, is considered a *strategic blunder* which has actually facilitated the country's drift into extremism and not allowed it the option of altering

its strategic calculus. In Pakistan's perception, the strategic depth policy has allowed it to maintain a conventional balance against India, but, on the other hand, this policy has made the tribal areas of Pakistan the hub of terrorism.

The doctrine of strategic depth has been considered outdated and rejected by several scholars who believe that with the overt nuclearisation of Pakistan, the doctrine has lost whatever meaning it had. According to the traditional approach (primarily based on the military aspect of the concept), the creation of strategic depth would allow a country's forces to move back deeper into their own territory, absorb the offensive thrust of the enemy, short of his military objectives, and also, apply power on the vulnerabilities of the attacking military.<sup>1</sup>

Strategic depth, when interpreted in purely military terms, can have three-fold offshoots: the first is where the combatant seeks strategic depth in his own territory; the second, when a state seeks strategic depth in the neighbouring country, extending its control in the foreign territory, and the state is, thus, able to trade territory for a better partner; and the third, when the state decides to create buffer states at its borders.

The second approach to strategic depth is ideological and religious, wherein the state tries to extend its control and influence by disseminating ideology or religious interpretation. In this context, China's efforts at spreading its Communist socialist ideology (through revolutions and war) for extending its control can be well understood.

In the case of Pakistan, one must remember that the classical model of strategic depth in relation to India simply cannot work because all its key cities and industries are within 70-odd km from the Indian border. Hence, any withdrawal westward would leave the soul of Pakistan in India's

**The doctrine of strategic depth has been considered outdated and rejected by several scholars who believe that with the overt nuclearisation of Pakistan, the doctrine has lost whatever meaning it had.**

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1. Air Cmde Jasjit Singh, "Strategic Search-Strategic Depth and the Question of the IAF's Strategic Posture", *AIR POWER Journal*, vol 2, no. 2, Summer 2007, pp. 11-26.

hands. What we need, therefore, is to understand the contours of Pakistan's concept and motivation for strategic depth. Essentially, it has adopted a mix of both the military and ideological approaches in order to gain strategic depth in Afghanistan. Pakistan has been overly concerned about having a hostile government in Afghanistan, and over the decades, has interfered in the Afghans' domestic politics. It has perpetually sought a 'friendly government' in Kabul. But, ironically, the relations between Afghanistan and Pakistan are scarred by turbulence and mistrust. The evolution of the concept of strategic depth took place in the context of the various strategic, political and ideological developments which surfaced in the 1980s and 1990s. However, the historical details in this context are not covered in this paper.

By using the term strategic depth, Pakistan seeks rationalisation of its control and influence in Afghanistan for a number of reasons which can be listed as follows:

- One of the most important factors in determining Pakistan's policies in Afghanistan is the lingering Afghanistan-Pakistan border issue based on the Durand Line, which separates the tribal areas of Khyber Pakhtoon Khwa (KPK) of Pakistan from Afghanistan. No Afghan regime, including the Rabbani government, has ever accepted the legitimacy of the border drawn up by the British in 1893 – the so-called Durand Line.<sup>2</sup> The Durand Line Agreement was to last for 100 years and expired in 1993. It was very clear that the Afghan regime would not recognise the agreement and would seek to incorporate the Pashtun areas east of the Durand Line into Afghanistan. As the Soviets were leaving in 1989 and the timeline for the expiry of the agreement (1993) too was close, Pakistan publicly pursued the doctrine of strategic depth, creating Afghanistan as a satellite state for itself.
- Pakistan has faced the issue of Pashtun nationalism which demanded a separate Pashtunistan from the 1940s. There have been concomitant calls

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2. The British accepted the traditional boundary roughly established by Ranjit Singh along what came to be known as the Durand Line based on the agreement between Emir Abdul Rehman, the ruler of Afghanistan, and Sir Henry Mortimer Durand, British foreign minister, in 1893, leaving the majority of the Pashtun population and tribes in India.

for an independent Pashtun homeland in the Federally Administered Tribal Areas (FATA), KPK and parts of Baluchistan. These areas have been alienated and grossly underdeveloped for decades, and the state has always had unique administrative and legislative arrangements which successive governments have used to administer the region. The Pakistani leadership which anyway was extremely dissatisfied with the small size of the country, that Jinnah had called a “moth-eaten” Pakistan, certainly wanted to prevent the creation of Pashtunistan and, thus, further disintegration of Pakistan. Control and influence over Afghanistan by a Pashtun dominated (essentially Taliban) government would, therefore, reduce the demand for Pashtunistan and yet have the Pashtuns under Pakistan’s control.

- During the 1965 War, Pakistan managed to move its aircraft to the Iranian airfields of Zahedan across the Baluchistan border. Pakistan was not certain that the same facility would be available in the future. Therefore, for protecting its aircraft against Indian strikes, Pakistan looked at the airfields in Afghanistan, but their use by the Pakistan Air Force (PAF) would be conditional to the government in Kabul agreeing to it. Pakistan’s military objective was to use the Afghan territory and air bases as a sanctuary for Pakistan. The Afghan territory would also provide the military with a much larger space for combat training without the risk of being monitored by the radars on the Indian side.
- Pakistan has followed the strategy of covert war through terrorism against India for more than 25 years now. The strategy is not new and Pakistan’s first aggression in 1947 was initiated in the name of tribal revolt and, thus, the same was repeated in Operation Gibraltar in 1965. Pakistan’s covert war against India has been much more active since the late 1980s which can be correlated to the expertise gained as a frontline state during the Afghan War and also acquisition of nuclear technology in 1987. Afghanistan provided Pakistan a safe haven to train the Islamist militants such as the Harakat-ul-Mujahideen (HuM), Jaish-e-Muhammad (JeM) and Lashkar-e-Tayyeba (LeT), which were to conduct terrorist activities in Jammu and Kashmir (J&K) and, eventually in other parts of India,

including Punjab. A pro-Pakistan government in Kabul would certainly be much more supportive of Pakistan using Afghanistan to nurture these groups.

- Undermining the Indian influence in Afghanistan has always been a priority for Pakistan. A former French diplomat, Frédéric Grare, has said, “According to Pakistan, whatever India does in Afghanistan is a ploy against Pakistan, be it economic investment, infrastructure, or any related matter....As a result, Pakistan has ensured that Indian interest would be blocked whenever and wherever possible”.<sup>3</sup>
- Islamabad has always viewed India’s actions in Afghanistan as a policy of encirclement and, thus, in its view, a radical Islamist regime – the Taliban – would help to cut down India’s role in the region.
- Pakistan’s control over Afghanistan gives it access to the Central Asian Republics. Pakistan is undoubtedly keen to expand its options for energy transportation due to the increasing demand for energy in the country. It wants to occupy the commercial and strategic space in the Central Asian Republics before India can expand its influence.
- Lastly, and very importantly, by using the normally not well understood terminology “strategic depth”, which sounds impressive, the Pakistani leadership could influence the public opinion in support of its policies.

### SUCCESS OF STRATEGIC DEPTH

How successful Pakistan’s policy of creating strategic depth in Afghanistan has been is, obviously, a matter of debate, although the general consensus is that Pakistan’s Afghanistan policy has been, by and large, unsuccessful. Pakistan supported the Taliban regime in the 1990s for strategic objectives but did not get the desired results. The Pakistani leadership miscalculated that the Taliban regime in Afghanistan would lead to recognition of the Durand Line and also, Pashtun nationalism would be much more under control. But, obviously none of the Pakistani assumptions came true: the Durand Line issue remained, Pashtun nationalism has been further

3. Frédéric Grare, “Pakistan”, in Ashley Tellis and Aroop Mukharji, eds., *Is a Regional Strategy Viable in Afghanistan* (Washington, D.C: Carnegie Endowment for International Peace, 2010), p. 21.

nurtured by the Taliban and New Delhi remains important for Afghanistan and enjoys soft power in Kabul.

Pakistan had some success in keeping the government in Kabul weak and under some control. It has managed to create bilateral trade relations with Afghanistan and is Kabul's leading trading partner. The long awaited Afghan-Pakistan Transit Trade Agreement (APTTA) which was signed in October 2010, was implemented in June 2011. Trade between Afghanistan and Pakistan is rising steadily. But the fact remains that Pakistan has failed to generate any goodwill amongst the Afghans. The political leadership in Kabul has been increasingly apprehensive about Islamabad's intentions and role in Afghanistan.

Pakistan's continued support to the Afghan Taliban and other extremist factions allowed the insurgency to resurface in 2003, during the Musharraf regime. Continued Pakistani support has not allowed the insurgency to dissipate. Islamabad has been unable to exercise its soft power influence in the neighbourhood. The general opinion in Afghanistan resists Pakistan's involvement in the country and the Pakistani elites are well aware of this. *Dawn*, a leading Pakistani daily reported: "...how can Afghanistan be our 'strategic depth' when most Afghans hate our guts, not only the northerners, but even those who call themselves Pakhtuns?"<sup>4</sup>

Although Pakistan has recently displayed interest in the peace talks and has tried contributing in the negotiations between the Afghan government and the Taliban, certainly the underlying aim which directs Islamabad's moves has been to have a pro-Pakistan government in Afghanistan. Pakistan has lately refrained from using the term 'strategic depth' and has denied its urge for seeking strategic depth in Afghanistan. But clearly, Pakistan's objectives in Afghanistan have not been altered and, thus, it will continue to expand its influence in Kabul.

## **INDIA'S INTERESTS AND ROLE IN AFGHANISTAN**

India-Afghan relations have gone through changes owing to strategic developments, but, by and large, post 2001, the two countries have shared

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4. Kamran Shafi, "Defining Strategic Depth", *Dawn*, January 19, 2010.

**The location of Afghanistan at the strategic crossroads between South Asia and Central Asia as well as South Asia and the Middle East, makes Kabul extremely important for India.**

a cordial relationship which has not been limited to governmental exchange, but has also been driven by strong people-to-people contacts. As Afghanistan proceeded towards transition, India's position was, and has been, of a supporting actor focussed on development and capacity building in Afghanistan.

India has deep-rooted civilisational ties with Afghanistan and both countries have historically shared a good relationship. The location of Afghanistan at the strategic crossroads between South Asia and Central Asia as well as South Asia and the Middle East, makes Kabul extremely important for India. India's relationship with Kabul did suffer a major blow during the Taliban's seven-year rule in the 1990s, when India continued to support the Northern Alliance. Ever since the fall of Taliban and installation of an Interim Authority in 2001, India has been active in its approach towards Afghanistan and its engagement with Kabul has been multi-dimensional. Stability in Afghanistan is important for India, and New Delhi has made consistent efforts to contribute towards it. India has growing stakes in peace and stability in Afghanistan. Its policy in Afghanistan faces multiple challenges, and the most significant is obviously Islamabad's approach, which has been rather disparaging and invariably perceives India's role in Afghanistan as a threat.

Ranjan Mathai, former foreign secretary of India, very eloquently talked about India's concerns in Afghanistan as it transitions:

Afghanistan is passing through a critical phase as it transitions towards a greater responsibility for its own security and governance and as NATO/ISAF forces move from a combat-role to an advise, train and assist role. Success or failure of this transition process will impact security and stability for many years to come, not just in Afghanistan but also in Afghanistan's immediate neighbourhood, particularly in Central Asia and South Asia. For many of us who are Afghanistan's immediate neighbours, we have

neither the luxury of a 'withdrawal' or a 'drawdown' from the situation that prevails in that country today.<sup>5</sup>

### *India's Interests in Afghanistan*

India has had historical and cultural linkages with Afghanistan and has been in favour of increasing ties with Kabul. Assistance to Afghanistan is part of India's strategy to carve out its own position in South Asia as an influential regional power. New Delhi wants to establish its credentials as a preeminent power and is keen to play a role in the stability of its neighbourhood. India's

geographical size, development of human resources and economic growth qualify it to take that positioning. Also, India's economic and military growth in the last two decades has been significant, and has complemented its strategy to expand its regional influence.

India's growth as an economic power and its integration into the global economy has certainly led to its image boost and, more importantly, the positive perception that it can assist stability around it. Moreover, New Delhi, as a responsible big power, cannot afford to have an unstable Afghanistan in the neighbourhood.

Pakistan has always tried to thwart India's efforts and moves in Afghanistan. For Islamabad, Afghanistan was one of the most logical choices to be used to balance India's influence in South Asia. A pro-India regime in Afghanistan was never acceptable to Pakistan as it would counter Pakistan's objectives. The Pashtun-ethnic linkage enables Pakistan to retain a leverage in Afghanistan.

Afghanistan provides Pakistan a safe haven to train the anti-India state sponsored groups which have been actively conducting terrorist activities

**Assistance to Afghanistan is part of India's strategy to carve out its own position in South Asia as an influential regional power. New Delhi wants to establish its credentials as a preeminent power and is keen to play a role in the stability of its neighbourhood.**

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5. Keynote Address : Ranjan Mathai, foreign secretary, India, at the Fifth IISS-MEA Foreign Policy Dialogue, London, October 4, 2012.

in J&K, and also in other parts of India. One of the prime objectives of Pakistan in pursuing its strategy of strategic depth was to use Afghanistan as a sanctuary to train and equip the anti-India terror groups. It is essential for India to have firm ground in Afghanistan and retain its political and diplomatic influence in Kabul to be able to control Islamabad's ambitions.

Another major concern of India is to control the spread of Islamic extremism. India has suffered from terrorism backed by Islamic extremism in the Valley and also in other parts of India (Punjab). The problem of Islamic extremism in Pakistan and Afghanistan affects India both directly and indirectly. Since a majority of the anti-India groups which have been nurtured by Pakistan for decades have their support base in Afghanistan, and draw their ideological and logistical support from the international terrorist organisations based in Afghanistan, India's concerns regarding spread of extremism in Afghanistan are not unjustified.

Afghanistan is also viewed by India as the gateway to Central Asia where New Delhi wants to expand its presence due to India's inflating energy requirements. According to the World Bank ICP Report 2011, India is the third largest economy in the world by share of the world Gross Domestic Product (GDP) in Purchasing Power Parity (PPP) terms.<sup>6</sup> Given the fact that the Indian economy is growing at a rapid pace, the energy requirements for India are obviously high – it is the fourth largest energy consumer in the world. Central Asia, with its rich natural energy resources, is vital for India, and Afghanistan is New Delhi's route to Central Asia. India is certainly interested in the imports of oil and uranium from both Kazakhstan and Uzbekistan. Turkmenistan is the fourth largest gas reserve holder and one of the top natural gas producers. Other major powers like the US, China and Russia have already started to expand their role and influence in Central Asia. Consequently, New Delhi needs to adopt an assertive policy to be able to maintain its influence.

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6. "2011 International Comparison Program Summary Results Release Compares the Real Size of the World Economies", *The World Bank*, April, 29, 2014, <http://www.worldbank.org/en/news/press-release/2014/04/29/2011-international-comparison-program-results-compare-real-size-world-economies>. Accessed on December 15, 2014.

*India-Afghanistan: A Developmental Partnership*

While India's role was constrained in Afghanistan during the anti-Soviet *jihad* between 1979-89, it did try to extend its support and activities in Kabul after the Soviet withdrawal. Also, during the Taliban regime in the 1990s, India's role remained restricted. Post 2001, the focus of the Indian activities has been on developmental projects, including the industrial, hydro projects, education and health sectors as well as humanitarian assistance. India's role post 2001 needs to be analysed not only in the context of the historical ties between Kabul and New Delhi, but also due to India's changing stature and role on the global platform, with its growing power, economy and image.

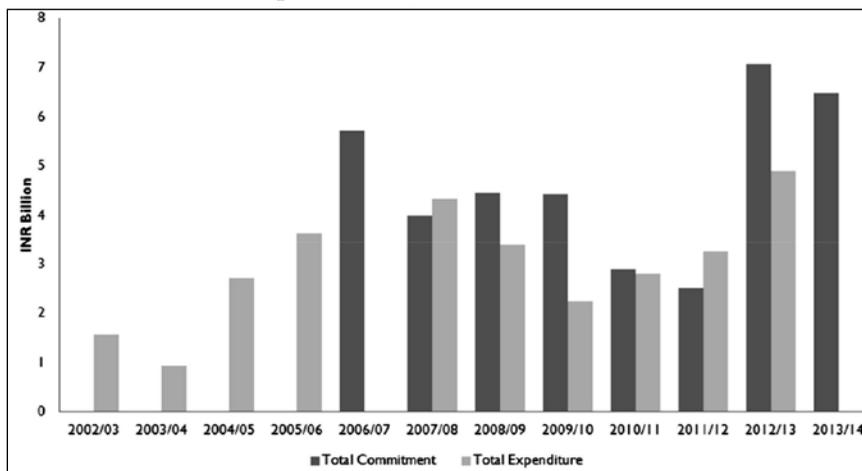
India is a key donor to Afghanistan and the cumulative level of commitment of Indian assistance to Afghanistan amounts to US\$2 billion. The Strategic Partnership Agreement signed between India and Afghanistan in 2011 provided a further boost to the relationship. India is the fifth largest provider of developmental assistance to Afghanistan with a total commitment for 2013-14 at approximately US\$120 million<sup>7</sup> (Fig 1). India's grant and loan-based allocations towards Afghanistan remain unaltered between Financial Year (FY) 2014-15 and FY 2015-16 (Fig 2). India's commitments to Afghanistan stand at INR 6.76 billion.<sup>8</sup> The cooperation is likely to increase in the future, but, obviously, much depends on how the relationship takes shape with the new regime led by Ashraf Ghani in Kabul.

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7. Rani D. Mullen, "India-Afghanistan Partnership" *Indian Development Cooperation Research*, <http://idcr.cprindia.org/blog/india-afghanistan-partnership>. Accessed on April, 14, 2015.

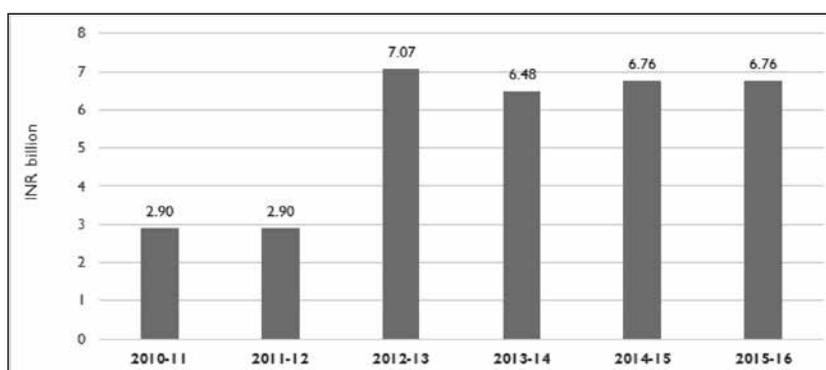
8. "Update on Afghanistan-India Relations", *Indian Development Cooperation Research*, April 25, 2015, <http://idcr.cprindia.org/blog/update-afghanistan-india-relations>. Accessed on May 25, 2015.

**Fig 1: India’s Development Cooperation with Afghanistan: Commitments and Expenditures, 2002-03 – 2013-14**



Source: Preliminary calculations by the Indian Development Cooperation Research (IDCR) initiative at the Centre for Policy Research, New Delhi, based on data from Ministry of External Affairs (MEA) Outcomes Budgets 2006/07-2013/14, Government of India and Union Budgets 2002/03 - 2013/14, Ministry of Finance, Government of India, as cited in Rani D. Mullen, “India-Afghanistan Partnership,” Indian Development Cooperation Research, <http://idcr.cprindia.org/blog/india-afghanistan-partnership>

**Fig 2: Indian Grant and Loan-Based Commitments to Afghanistan in INR Billion (between 2010-11 and 2015-16)**



Source: Calculations by the Indian Development Cooperation Research (IDCR) initiative at the Centre for Policy Research, New Delhi, based on available data from the Union Budget 2014-15, Ministry of Finance, Government of India, as cited in “Update on Afghanistan-India Relations”, Indian Development Cooperation Research, April 25, 2015, <http://idcr.cprindia.org/blog/update-afghanistan—india-relations>. Accessed on May 25, 2015.

### *India's Soft Power in Afghanistan*

India has been actively involved in the developmental projects in Afghanistan and has played a significant role in the reconstruction and rehabilitation of Afghanistan. India is one of the leading donors in Afghanistan and, by far, the largest regional donor. Obviously, India's role has been constrained given the circumstances and Pakistan's continuous unhappiness over Indian presence as well as its soft power enhancement in Kabul. The efforts by the Indian government clearly indicate that New Delhi believes that the sustainable development of Afghanistan requires long-term investment. Specifically, investment that can assist the exploitation of Afghanistan's natural resources. A stable Afghanistan is essential for regional stability. As Jayant Prasad has said:

India's objective is to stabilise Afghanistan. Getting the Afghans to stand on their own feet is good for the Afghan people, good for India and good for the world, including all the regional countries.<sup>9</sup>

India's influence in Afghanistan is quite significant and it is able to wield a considerable amount of soft power. On August 30, 2009, in a confidential report submitted to US President Obama, by Gen Stanley McChrystal, he wrote:

Indian political and economic influence is increasing in Afghanistan, including significant development efforts and financial investment. In addition, the current Afghan government is perceived by Islamabad as pro-Indian. While Indian activities largely benefit the Afghan people, increasing Indian influence in Afghanistan is likely to exacerbate Pakistani countermeasures in Afghanistan or India.<sup>10</sup>

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9. Jayant Prasad, Indian ambassador to Afghanistan, in an interview, in "Afghanistan, Indians are Praised Simply for Being Indian", *Business Standard* (New Delhi), October 9, 2009.

10. Ajay Prakash, "Rising Indian Influence in Afghanistan Worries US and Pakistan", *WSWS.org*, November 19, 2009, <http://www.countermeasures.org/print.html>. Accessed on April 12, 2013.

**The Bollywood movie industry – which makes close to 800 movies every year portraying glamorous lifestyles and events – has permeated the Afghan society. These cultural products have penetrated deeply into the Afghan society and are watched with great fondness by the Afghans.**

India's developmental programmes do impact the Afghan lives directly and some of the high profile Indian projects like the building of the Afghan Parliament and donation of planes to Ariana Afghan Airlines have created a significant positive image of India. The Bollywood movie industry – which makes close to 800 movies every year portraying glamorous lifestyles and events – has permeated the Afghan society<sup>11</sup> These cultural products have penetrated deeply into the Afghan society and are watched with great fondness by the

Afghans. One of the most popular TV shows in Afghanistan is an Indian soap dubbed in the *Dari* language.<sup>12</sup> The entertainment industry and the education sector impact the youth in the country, and India's role in these sectors has enabled it to gather support from the Afghan youth.

India has also made an effort to create linkages with the Afghan elites who have had long standing ties with India. Hamid Karzai, for example, studied in India in Himachal Pradesh and speaks fluent Hindi, and Abdullah Abdullah's wife resides in New Delhi. There have been specific efforts to increase business partnerships with Afghanistan which have attracted elite business personnel from Afghanistan, further building up credibility for India: for example, the Investment Roadshow in Ahmedabad in 2014, the participation of the Afghan delegation in the India Mining Summit in 2014, inauguration of the 'India Bazaar' in Kabul in 2014, and the participation of Afghan businessmen in PHARMEXCIL 2015 in Gujarat.<sup>13</sup>

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11. "What is Bollywood", *Newsround*, undated, as cited in Larry Hanauer and Peter Chalk, "India's and Pakistan's Strategies in Afghanistan: Implications for the United States and Region", *Occasional Paper, RAND*, Centre for Asia Pacific Policy, 2012, p. 21.

12. Shashi Tharoor, "Hooray for Bollywood: India's 'Soft Power' ", *Taipei Times*, January 7, 2008, as cited in Hanauer and Chalk, *Ibid.*, p. 21.

13. "India-Afghanistan Relations", January 2015, Embassy of India, Kabul, Ministry of External Affairs, New Delhi.

### **CHINA'S INTERESTS AND EMERGING ROLE IN AFGHANISTAN**

The last few years have witnessed increasing signs of Chinese interest and engagement in Afghanistan. In early 2014, Chinese Foreign Minister Wang Yi made a rare trip to Kabul for a meeting with his Afghan counterpart. Following which, in July 2014, China announced the appointment of a special envoy for Afghanistan (for the first time), under the Ministry of Foreign Affairs. Sun Yuxi, who is a former ambassador to both India and Afghanistan, has been appointed as a special envoy for Afghanistan. Beijing, is obviously keen to contribute in ensuring peace and stability in Afghanistan and official representation in Afghanistan is a welcome initiation. China clearly does not want Afghanistan to become a safe haven for South-Central Asian militants which would threaten its own stability in its western provinces.

Another significant move came from China in February this year (2015) when it offered to mediate in the prevaricated efforts to engage the Afghan Taliban in the peace process. Reuters reported that China has initiated mediation between representatives from Afghanistan, Pakistan and Taliban in the framework of a "peace and reconciliation forum". China's interest in Afghanistan has gone through a political, economic and military transition, and how China and Afghanistan perceive each other has also undergone a change. In the last few years, as the United States' drawdown was underway from Afghanistan, China raised its profile, and increased its involvement and presence in Afghanistan. China's policy towards Afghanistan in the last few years has been driven primarily by its economic interests and security concerns. China has been obviously worried about the rising Uighur secessionism in the western Xinjiang Uighur Autonomous Region (XUAR)

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bordering Pakistan Occupied Kashmir (POK) and Afghanistan. China is apprehensive about the proliferation of rising extremism and Talibanisation from the Afghan-Pakistan border into the restive Xinjiang.

### *China's Security Concerns in Afghanistan*

Security is the core concern of China as it shares an 85-km border with Afghanistan. Beijing's objective is stability, both internally in XUAR and externally, in Afghanistan. China faces a security challenge from the religious-separatist terrorist elements in Xinjiang, that have found a safe havens in Afghanistan and Pakistan. The ethnic Uighurs, who are (mostly) Muslims and culturally close to the Central Asian Republics, have had historical grievances with the majority ethnic Han Chinese of the People's Republic of China (PRC), and have been posing a serious internal threat to Beijing. Xinjiang, rich in vast mineral resources, is potentially an important trade route for China, and also home to Lop Nor, which was used by China to conduct a nuclear test for Pakistan.<sup>14</sup>

Historically, there have been tensions between the Uighurs and the Chinese government but after the collapse of the Soviet Union and the formation of the Central Asian Republics, the cries of self-determination from the Uighurs have increased significantly. As John K Cooley has observed:

During the opening years of the Afghan *jihād*, China joined the anti-Russian coalition. It did so far for its own strategic reasons. It paid a terrible price during the blowback period after the war's end. That price was the renewed and spreading revolt of the Uighurs, the Muslim and Turkic-speaking peoples of China's far west, the vast province of Xinjiang, many of whom who yearned for independence in their own Muslim state...<sup>15</sup>

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14. "Controlling Xingjiang: Autonomy on China's "New Frontier," *3 Asian-Pacific Law and Policy Journal*, vol 3, issue 1, Winter 2002, p.121.

15. John K. Cooley, *Unholy Wars: Afghanistan, America and International Terrorism* (London: Pluto Press, 2001), p. 66.

There have been numerous incidents of terrorist violence in Xinjiang, entailing the issue to be in the priority list of the central government. Since 1990, there have been several separatist uprisings, protests and killings of Han Chinese officials, and a dramatic rise in the demands for the creation of an independent "East Turkestan".<sup>16</sup>

Till now, the Chinese response to the Xinjiang insurgency and violence has been primarily with the use of force and suppression, with little economic incentives being offered to the region.<sup>17</sup> There has been lack of political means for combating the resistance and Beijing has been using harsh tactics. Little has been done to address the alienation of the region which has not allowed the insurgency to settle down. Rohan Gururatna, the head of the International Centre for Political Violence and Terrorism Research, at Nanyang Technological University in Singapore, says that the violence comprises acts of resistance by the "disaffected" Uighurs.<sup>18</sup>

China has been deeply concerned with the support these militants draw from the terrorist organisations based in Pakistan and Afghanistan. And, there have been numerous incidents in the past indicating this linkage. Beijing is concerned about the spread of separatist ideology from Afghanistan and the insurgency-prone regions of Pakistan. The Uighurs have been using Afghanistan and Pakistan as a sanctuary for a long time now. According to Ahmed Rashid:

Uyghur militants from Xinjiang, China are increasingly using Afghanistan as a sanctuary, a supply base for training and weapons, and a means to fund their movement back home through the lucrative opium trade. Heroin addiction is now a major social problem in Xinjiang. Although the Taliban are not directly recruiting Uyghurs into their forces, Uyghur militants have

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16. Teresa Poole, "Fresh Rioting in Xinjiang", *Independent*, February 20, 1999, as cited in n.14, p.122.

17. See Elizabeth Van Wie Davis, "Uyghur Muslim Ethnic Separatism in Xinjiang, China", Centre for Security Studies, January 2008, at <http://www.apcss.org/college/publications/uyghur-muslim-ethnic-separatism-in-xinjiang-china/>. Accessed on July 21, 2014.

18. Dan Levin, "At Least 50 killed in Xinjiang Violence, Officials Say", *The New York Times*, September, 25, 2014, at [http://www.nytimes.com/2014/09/26/world/asia/death-toll-in-xinjiang-violence-may-be-higher-than-reported.html?\\_r=0](http://www.nytimes.com/2014/09/26/world/asia/death-toll-in-xinjiang-violence-may-be-higher-than-reported.html?_r=0). Accessed on December 12, 2014.

enlisted with, and get support from, the foreign Islamic units fighting for the Taliban. These units include the 800-man Arab brigade led by Osama Bin Laden, units of Pakistani student militants, and the 2,000-man force of the Islamic Movement of Uzbekistan led by Juma Namangani, now based in northern Afghanistan.<sup>19</sup>

China's additional worries arise from the support that Al Qaeda has pledged to extend to the militants in Xinjiang.<sup>20</sup> There have been reports in the West citing the fact that many Uighurs separatist of the East Turkistan Islamic Movement (ETIM) have deep links with Al Qaeda and have received, and continue to receive, training in the Al Qaeda camps in Afghanistan and also weapons (and training) from Pakistan. Post 9/11, the Chinese have been quite concerned about aggravation of the existing separatist movement due to the spillover effect from Afghanistan. China fears that the Uighurs have got in the past, and will continue to get, support from the transnational Muslim extremist forces. China is trying to ensure that the East Turkistan separatists do not benefit from the Taliban when the Western forces leave.

The second factor, which China also suffers from, is the drug problem from Afghanistan. A major share of the drugs entering China are smuggled into China from the Golden Crescent (meaning Afghanistan, Iran and Pakistan). The western province of China has been deeply affected by the drug export from Afghanistan, and Xinjiang, apart from serving as a transit route, has also been the final destination for the drug suppliers, with an increasing number of drug consumers.<sup>21</sup>

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19. Ahmed Rashid, "China Forced to Expand Role in Central Asia", *The Central Asia-Caucasus Analysis*, July 19, 2000, at <http://www.cacianalyst.org/publications/analytical-articles/item/7187-analytical-articles-caci-analyst-2000-7-19-art-7187.html>. Accessed on August 12, 2014.

20. See "Al-Qaeda Leader Ayman al-Zawahiri Sets out His First Jihad Guidelines", *Reuters*, September 18, 2013, at <http://www.scmp.com/news/world/article/1311795/al-qaeda-leader-ayman-al-zawahiri>. Accessed on January 12, 2015.

21. Nerkez Opacin, *China's Role in Afghanistan : A Capitalist Peace Approach* (Hamburg: Anchor Academic Publishing, 2014), p.38.

*China's Quest for Enhanced Economic Engagement*

China has enhanced its economic engagement with Afghanistan and has invested in the infrastructure, telecom industry and, quite substantively, in the energy sector. China's expanding energy requirements have been an important driver for its renewed engagement and interest in Afghanistan. The US Energy Information Administration (EIA) predicts that in the near future, China will account for one-third of the world's energy consumption. Afghanistan provides China with an opportunity to access minerals and other energy resources. China is keen to invest in the Afghan infrastructure as the new transit corridors would facilitate Chinese trade towards the west, into Iran and the Middle East, and towards the south, into Gwadar, Pakistan.<sup>22</sup>

China has extended economic assistance to Afghanistan and provided aid worth Yuan 1.3 billion (US\$ 203 million) and waived debts worth US\$19.5 million during 2002-10.<sup>23</sup> In 2012, when the Strategic Partnership Agreement was signed, Beijing pledged additional assistance of Yuan 150 million (US\$ 23.7 million). Although the Chinese contribution is a relatively small fraction as compared to that of the West, it does demonstrate an alteration in the Chinese foreign policy towards Afghanistan.

China has pledged an investment of \$3.5 billion in the Mes Aynak copper mines in Afghanistan's Logar province, which is the largest foreign direct investment in the Afghan history. China has emerged as the largest foreign investor in Afghanistan. In 2007, a 30-year deal was signed between the Afghan government and two Chinese state owned companies, the China Metallurgical Group Corporation and the Jiangxi Copper Company, to mine copper in the eastern region of Afghanistan, at the Aynak copper mine. In 2012, The Afghan Ministry of Mines made a statement, "The Aynak project represents the largest private sector project in the country's history, and it will generate more jobs, revenues and enhancements to Afghanistan's

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22. Zalmay Khalizad, "Why Afghanistan Courts China", *The New York Times*, November, 3, 2014, at [http://www.nytimes.com/2014/11/04/opinion/why-afghanistan-courts-china.html?\\_r=0](http://www.nytimes.com/2014/11/04/opinion/why-afghanistan-courts-china.html?_r=0). Sccessed on December 12, 2014.

23. Vishal Chandra, *The Unfinished War in Afghanistan 2001-2014* (New Delhi: Pentagon Press, 2015), p. 249.

**China has invested in the oil and natural gas sector, and in 2011, the Chinese state-owned China National Petroleum Corporation (CNPC) and Watan Energy, a local Afghan company, signed an agreement worth \$700 million. The agreement reportedly allows the Chinese firm to search for oil and natural gas in Sari Pul and Paryab, an area known as the Amu Darya river basin.**

infrastructure than any other single project to date...”<sup>24</sup>

The project would invariably generate opportunities for Afghans. According to the World Bank Report, the project would create 12,000 direct jobs and 62,500 “induced” jobs while adding \$250 million in annual revenues once the mine hits capacity.<sup>25</sup>

China has invested in the oil and natural gas sector, and in 2011, the Chinese state-owned China National Petroleum Corporation (CNPC) and Watan Energy, a local Afghan company, signed an agreement worth \$700 million. The agreement reportedly allows the Chinese firm to search for oil and natural gas in Sari Pul and Paryab, an area known as the Amu Darya river basin.<sup>26</sup> The area was first explored in the 1960s by the Soviets, who estimated the reserves at about 87 million barrels. The Chinese and Afghans believe the reserves to be much more than the originally estimated figure.<sup>27</sup>

The agreement includes the following: “(i) CNPC will build a refinery, which would be Afghanistan’s first refinery; (ii) the Afghan government will receive 70 percent of the profits from the sale of the oil and natural gas; and (iii) CNPC will pay 15 percent in royalties, as well as corporate taxes and rent for the land used for the operations.”<sup>28</sup>

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24. Kathleen Caulderwood, “China and Afghanistan’s Minerals: Archaeologists Still Scrambling To Save Mes Aynak”, *International Business Times*, August 25, 2014, at <http://www.ibtimes.com/china-afghanistans-minerals-archaeologists-still-scrambling-save-mes-aynak-1668808>. Accessed on November 11, 2014.

25. *Ibid.*

26. Patrick Quinn and Slobodan, “Afghanistan, China Sign First Oil Contract”, [Afghan News] December 28, 2011 - 02-26-2012, *PashtunForums*, at <http://www.pashtunforums.com/showthread.php?t=26211>. Accessed on February 12, 2015.

27. *Ibid.*

28. *Ibid.*

*Assessing Beijing's Engagement*

Beijing has kept itself aligned with the international community in the last few years and has increased its engagement in Afghanistan. China, by and large, maintains an independent policy on Afghanistan, primarily reflective of its deep security concerns and economic interests, which are the prime drivers of its proactive diplomatic engagement. Beijing certainly wants a stable Afghanistan, which does not become the home of, or sanctuary for, the Uighur militancy, but, on the other hand, it is conscious of the challenges which accompany engagement with Afghanistan. It has refrained from any direct military involvement in Afghanistan (till now!) but has offered assistance in military training. It has learnt from the troubles which the West has been facing, with 13 years of war in Afghanistan, leading to attracting the attention of international terrorist groups, and it certainly wants to avoid these problems. Also, many Afghans don't particularly view the Chinese as friends and sending armed forces into Afghanistan might not be a logical option, according to the Chinese leadership. China has been an eager player in the mediation with the Taliban, as it realises that the Taliban is a reality in Afghanistan which has to be involved in the (sustainable) political settlement.

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Being a large power and a committed ally of Pakistan (for over four decades now !), which would invariably be an important player in Afghanistan, China can actually play a significant role in the shaping of Afghanistan. According to Pakistan's Senate Defence Committee Chairman Mushahid Hussain:

Unlike Russia or the United States, China carries no historical 'extra-baggage' and unlike Pakistan, Iran, Turkey or the Central Asian Republics, China has stayed away from all previous conflicts or civil wars in Afghanistan, therefore, it is not tainted in any way as far as the Afghan people are concerned, and unlike the increasingly bankrupt West, China has the financial resources to sponsor much-needed investment in key sectors of Afghanistan's development.<sup>29</sup>

Dr Davood Muradin, director general of the Afghan Institute of Strategic Studies, has also commented that China, being the most prosperous and important neighbour of Afghanistan, can play a very important role.<sup>30</sup>

Looking into the recent developments, the following conclusions could be drawn regarding China's emerging role in Afghanistan:

- The Xinjiang province and its problems have a linkage with Afghanistan and have received assistance in the past from the groups operating from Afghanistan and Pakistan. Thus, the Chinese engagement is aimed to primarily take care of the security concerns and to ensure the containment of the spillover effect of extremism and terrorist groups operating in the neighbourhood.
- China's quest for energy has led to investments in the Afghan energy sector. Certainly, it aims to build up the transportation network which would connect it to the Iranian oilfields and Central Asian Republics, and also Gwadar in Pakistan.
- A good foothold in Afghanistan would certainly provide leverage to China in terms of containing the expansion of the other major players – the US and Russia – in the region.
- China wants stability in Afghanistan but has no plans of stabilising Afghan politics, facilitating its ethnic rivalries and modifying its social structure.

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29. "Pakistani, Afghan Experts Eye China's Greater Role in Afghanistan", *Daily Times*, October 26, 2014, at <http://www.dailytimes.com.pk/national/26-Oct-2014/pakistani-afghan-experts-eye-china-s-greater-role-in-afghanistan>. Accessed on January 10, 2015.

30. *Ibid.*

- China would enhance investment in the social sector like building hospitals, roads and cultural institutes promoting Chinese culture, in order to build goodwill among the Afghans.
- China is likely to continue to maintain and enhance its diplomatic and economic engagement in Afghanistan as stability in Afghanistan is in Beijing's interest.

### **AFGHANISTAN: A BATTLEGROUND OF DIVERGENT INTERESTS AND APPROACHES**

Afghanistan is indeed going through a challenging phase of transition on three fronts: political, economic and, most critical, security. On the political front, a unique power sharing deal has been negotiated between President Ashraf Ghani and CEO Abdullah. The new political regime has established its legitimacy but it still needs to establish its credibility within the country. Political factionalism and ethnic factions have grown tremendously along with the raging insurgency and terrorist outfits in Afghanistan posing severe challenges to the stability in future. The divisions between Pashtuns and non-Pashtun nationalities that make up for the complex weave of the Afghan national carpet, are deep-rooted.

The Taliban and their Pakistani patrons appeared ready for an agreement in the past few months, but have continued attacks on the government outfits, expressing their rage against the state and foreign powers. It is ironical that even with the initiation of the peace talks, with the help of Pakistan and China, the spring offensive announced by the Taliban in 2015 continued, with fierce and frequent attacks within Afghanistan. The NATO troops claimed to have taken hundreds of Taliban off the battlefield every year (during the military operations) and the average age of the Taliban fighters has decreased to 23 from 35 earlier, and they remain the most crucial factor in the future of Afghanistan. The Taliban still maintain ties with Al Qaeda and cooperate with the outfit in some eastern provinces. The emergence and expansion of the relatively new non-state actor Islamic State in Syria (ISIS) has complicated the security matters even more in Afghanistan. Kabul becomes a natural

choice for the ISIS, as a turbulent state with strong factions of radical ideology presents fertile ground for its future planning and actions.

The future of Afghanistan will depend on multiple factors and the role of the state institution is obviously critical. The effectiveness of the political leadership to resolve and balance the ethnic divides, progressive economic planning, and managing relationships with the US and regional powers are the critical factors required for stability in Afghanistan.

While undoubtedly the onus of stabilisation and national growth is on the state itself and external assistance is always restrained in terms of state building, in the case of Afghanistan, the role of the major regional powers, Pakistan, India and China, is extremely important. The political and ethnic dimensions in Afghanistan are influenced by Pakistan to a large extent. The leadership in Islamabad plays a crucial role in the political and social power politics of Afghanistan. The Afghan economy is largely aid-dependent and will need external support for a long time to be able to sustain itself and eventually grow. The country is reportedly rich in minerals but the exploitation of these minerals demands heavy foreign investments. The foreign investments depend on the security situation in the country and consistent security challenges would certainly dissuade the investors.

Although Pakistan is struggling economically and faces severe security challenges within, with rising extremism, it is certainly the most influential actor in the stability or, for that matter, instability of Afghanistan. Not only the geographical proximity, but the strong religious and ethnic ties which the two countries share, place Pakistan in a dominant position to shape the future of Afghanistan. While Islamabad refrains from using the term “strategic depth”, it has shown little signs of change in its objectives in Afghanistan. Contrary to the world opinion which does not support the Taliban, Pakistan continues to treat them as its strategic asset and patronises them. Pakistan’s ambitions and its desire to control Afghanistan to be able to fulfill its objectives have till date not allowed Kabul to stabilise. Pakistan’s support to the “selective” non-state actors and its ambition to use the Afghan territory to further

its strategic interests (against India) have not allowed the insurgency to settle down in Afghanistan.

The military in Pakistan remains centred on catering to its strategic interest, and its desire for “strategic depth” is unlikely to change. The new regime in Afghanistan under President Ghani did try for a new beginning with Pakistan and, in a rather surprising move (different from his predecessor, Karzai), Ghani visited Pakistan before approaching Afghanistan’s developmental partner, India. The relationship between Afghanistan and Pakistan remains stressed, with mistrust and constant accusations, and it is difficult to predict how the ties will shape up in the future.

China’s role is evolving in Afghanistan and is dominated primarily by its security and economic interests. Beijing is increasing its footprint in Afghanistan with not only heavy economic investments, but also trying to play an active role in the peace talks. With its economic profile, China can potentially play an effective role in boosting the Afghan economy in the future, but currently, the Chinese position and policies are more or less targeted to cater to its security and economic interests.

India shares strong historical and cultural ties with Afghanistan, has strategic and economic interests in the region and desires the stability of Afghanistan. India’s interests have multiple dimensions which range from expansion of its regional influence, building its soft power, trade and commerce, countering the growth of Islamist extremism from Afghanistan and deterring Pakistan from using Afghan territory for sponsoring terrorism against India. New Delhi has adopted a completely different approach as compared to the other regional powers (Pakistan and China) and has been engaged in developmental and humanitarian assistance in Afghanistan. As a multi-ethnic democracy, with a growing economy, India is able to project an extremely positive image. India’s initiatives do impact the Afghan society directly and, thus, it enjoys immense popularity in the country. India has refrained from any form of military engagement in Kabul, apart from contributing towards the capability of the Afghan forces through training, etc.

Pakistan has till date, tried to thwart all Indian efforts in Afghanistan and India's growing popularity is detrimental to Pakistan's interests in Kabul. Islamabad certainly wants to contain New Delhi's role in Afghanistan and its ability to manage its moves would be encouraged further with the strong presence of China in the Afghan territory. With the Chinese present in Afghanistan, Pakistan now has a strong partner to conduct itself in Kabul. On the other hand, China certainly gets support for its economic and security related activities due to Pakistan's role in Afghanistan. The challenges for India are likely to increase with the engagement of the two major players in Afghanistan, that have a close alliance between themselves.

The three regional players that actually have the potential to contribute in the stability of Afghanistan, have different interests and follow different policies, which are mostly contradictory in nature. The solution to the Afghan crisis demands a regional approach, with integrated policies complementing each other.

# HAS THE US ADMINISTRATION GONE SOFT ON CHINA, LEADING TO ITS RISE?

**TEMJENMEREN AO**

This paper studies the growth of China in the post-Cold War period after the formal establishment of the US-China normalisation under the Carter Administration. It would make an attempt to understand how this unprecedented rise of China could well be attributed to the US Administration turning a blind eye to China, as a result of various political and economic compulsions. This inaction by the US Administration has been viewed as the US going soft on China despite its illicit activities in the realms of its trade malpractices, weapons proliferation and human rights violations, to name a few. The paper would look into the illicit transfers of nuclear and other military technologies by China to the states of Pakistan and Iran, through which it attempts to showcase how China, by transferring sensitive technologies, has enabled these nations to achieve full scale military capabilities. Despite its actions that should have called for a serious US policy overhaul, the US Administration has continued to engage China, and in view of the implementation of its policy towards the country, it could be termed as going soft on it.

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**“We could press home that China as an important member of the World Community should set a positive example in acting to work against proliferation and nuclear weapons....”**

#### **ON CHINA’S PROLIFERATION POLICY**

According to a cable sent by the US Embassy at Beijing, to the State Department on December 17, 1982<sup>1</sup>, China’s position on arms control is dominated by three considerations:

- To preserve China’s freedom of action, eventually to overcome its inferior power position.
- To preserve and highlight China’s Third World credentials by not seeming to join an exclusive nuclear club that seeks to retain a monopoly.
- To project an image of a responsible member of the international community.

The cable also stated “...commercial as well as political considerations lie behind China’s supply of conventional arms to a number of Third World countries.... Commercial considerations are dominant in China’s export of some non-safeguarded sensitive nuclear materials such as uranium and heavy water....” The cable stressed on the need to ensure that China is made aware of the dangers posed by its unsafeguarded nuclear exports which could be readily diverted to destinations that the Chinese themselves would not approve of, and thereby heighten the risk of nuclear proliferation. Since China was still not a member of the International Atomic Energy Agency (IAEA) during this period, the US Administration was keen that the Chinese undertake safeguards parallel to those required by the IAEA and also offered to make American experts available to the Chinese in order to explain procedures employed in designing safeguards. Furthermore, the cable added “... We could press home that China as an important member of the World Community should set a positive example in acting to work against proliferation and nuclear weapons....”.<sup>2</sup>

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1. US Department of State, “Arms Control and Disarmament”, US Embassy China, Cable 17090, *The National Security Archive*, December 17, 1982, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-8.pdf>. Accessed on June 22, 2015.
  2. Ibid.

In the 1980s, China began active participation in the realm of weapons non-proliferation, firstly, by becoming a member of the IAEA in 1984 and adopting a policy that required IAEA safeguards on its nuclear exports. China also announced that it would not assist other countries to develop nuclear weapons and, in 1989, concluded an agreement with the IAEA for the application of safeguards in China. A declassified cable from the US Embassy in China to the Department of State, Washington DC, dated April 16, 1991, stated that despite China still not being a signatory to the nuclear Non-Proliferation Treaty (NPT), the People's Republic of China (PRC) has frequently stated in public that it supports the three goals of the NPT:

**China also announced that it would not assist other countries to develop nuclear weapons and, in 1989, concluded an agreement with the IAEA for the application of safeguards in China.**

- Preventing the spread of nuclear weapons to non-nuclear states.
- Reducing nuclear weapons arsenals worldwide.
- Promoting the peaceful use of nuclear energy.

Based on their support to these principles, the Chinese have developed three principles which govern their nuclear cooperation with other countries:

- They will only cooperate on projects which fall under IAEA safeguards.
- They will not cooperate on projects geared towards weapons development.
- They will not cooperate on projects geared towards the transfer of technology to third countries.<sup>3</sup>

In 1992, China set aside its criticism of the NPT and became a party to the treaty, thereby assuming legally binding commitments not to assist non-nuclear weapons states to acquire or manufacture nuclear weapons and to require safeguards on its nuclear exports to non-nuclear weapon

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3. US Department of State, "Proliferation Issues: The View from Beijing Looks Grim", US Embassy China, Cable 1884, *The National Security Archive*, April 16, 1991, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-19.pdf>. Accessed on June 23, 2015.

states. In 1995, China supported the indefinite extension of the NPT. In 1996, China announced a moratorium on nuclear explosive testing in July, and signed the Comprehensive Test Ban Treaty (CTBT) in September. Also, in 1996, China publicly committed itself not to assist unsafeguarded nuclear facilities. With respect to nuclear exports controls, China took a number of steps in 1997 to establish an effective and comprehensive national nuclear export control system. On May 27, 1997, China issued a "State Council Notice Regarding Strict Implementation of China's Nuclear Export Policy". This notice stated China's policy of "not advocating, not encouraging and not carrying out nuclear weapons proliferation and not assisting other countries in developing nuclear weapons"<sup>4</sup>. In addition, the notice stated that China's nuclear export policy would limit nuclear export items only for peaceful purposes to be exported under IAEA safeguards and transferred to third parties only under IAEA safeguards.<sup>5</sup> Also in May, China attended the Zangger Committee's<sup>6</sup> semi-annual meeting as an observer, and in October, China attended the Zangger Committee as a full member. In September 1997, China promulgated nation-wide nuclear export control regulations accompanied by a list of controlled nuclear items which the Chinese side stated is identical to the trigger list adopted by the Nuclear Suppliers Group (NSG). The new nuclear export control regulations restate China's nuclear export policy:

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4. *The National Security Archive*, (1997), <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-26.pdf>. Accessed on June 24, 2015.
  5. The State Council notice that was sent to all Chinese government ministries and non-governmental entities, directed that the export of nuclear materials, nuclear technology, and non-nuclear materials used in reactors would be exclusively undertaken by the China National Nuclear Corporation (CNNC) and other government-designated corporations. The notice provided for a system of peaceful-use guarantees, end-use certificates and supervision by relevant government departments over all nuclear-related exports to both nuclear and non-nuclear facilities. The notice also specifically covered the transfer of nuclear technology as well as the exchange of technical personnel or technical information.
  6. The Zangger Committee was formed in the early 1970s to establish guidelines for implementing the export control provisions of the nuclear Non-Proliferation Treaty [Article III (2)]. According to the Article, each state party to the treaty undertakes not to provide (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material to any non-nuclear-weapon state for peaceful purposes, unless the source or special fissionable material is subject to the safeguards required by this Article.

- All exports are for peaceful purposes.
- Recipients must accept IAEA safeguards.
- No re-export to a third country without Chinese government approval.<sup>7</sup>

To sum up, it could be concluded that throughout the 1980s and 1990s, China agreed to participate in most of the major multilateral arms control regimes. These included the International Atomic Energy Agency (1984); the Biological Weapons Convention (1984); the Limited Test Ban (1986); the Non-Proliferation Treaty (1992) and its indefinite extension in 1995; and the Chemical Weapons Convention (1993). China followed the US as the second signatory to the Comprehensive Test Ban Treaty in 1996. In addition, China agreed to join the Zangger Committee in 1997, and the same year, it also agreed to a list of nuclear export controls very similar to those of the NSG that establishes guidelines for the nuclear Non-Proliferation Treaty (NPT) export control provisions. China made a number of additional commitments in November 2000 by agreeing not to assist any country in the development of ballistic missiles that could be used to deliver nuclear weapons<sup>8</sup> and also ensured that it would further improve its export control system. In 2002, China issued its missile export control regulations and an associated control list.<sup>9</sup>

In October 2002, North Korea's nuclear ambitions became clearer and closer to reality, with Pyongyang acknowledging its uranium enrichment programme, ousting IAEA inspectors in December 2002, and announcing its withdrawal from the NPT in January 2003. After North Korea's revelations of having a nuclear enrichment programme and also its claims of having nuclear weapons in May 2003, the Chinese leaders issued highly

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7. China is finalising a similar system of export controls on nuclear-related dual-use items. At the October Zangger Committee meeting, China issued a statement which indicated that government departments have the right to exercise "catch-all" authority over nuclear dual-use items. See "Classified Report to Congress on the Non-Proliferation and Practices of the People's Republic of China", *The National Security Archive* (1997), <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-26.pdf>. Accessed on June 24, 2015.

8. These include missiles capable of delivering a payload of at least 500 km to a distance of at least 300 km.

9. Jennifer Weeks, "Sino-US Nuclear Cooperation at the Cross-Roads", *Arms Control Associations*, 1997, [http://www.armscontrol.org/act/1997\\_06-07/weeks](http://www.armscontrol.org/act/1997_06-07/weeks). Accessed on June 25, 2015.

**In June 2006, Beijing joined other permanent members of the UNSC and Germany to present Iran with a political and economic incentive package in the hope of gaining Tehran's agreement to suspend its enrichment activities.**

public statements insisting that the Korean Peninsula should be free of nuclear weapons. According to US Assistant Secretary of State for Arms Control Stephen Rademaker, the Chinese authorities worked with the US in the fall of 2003 to interdict a chemical shipment destined for North Korea's nuclear weapons programme.<sup>10</sup> In July 2006, China joined all the members of the United Nations Security Council (UNSC) in unanimously supporting Resolution 1695 in response to North Korea's missile test.

In June 2006, Beijing joined other permanent members of the UNSC and Germany to present Iran with a political and economic incentive package in the hope of gaining Tehran's agreement to suspend its enrichment activities. However, Iran continued to defy the UNSC appeal and, therefore, Beijing, along with the other permanent members as well as the other nine additional UNSC members, passed Resolution 1696<sup>11</sup> on Iran. The action undertaken by China against Iran for the first time showed its resolve and willingness to support international non-proliferation efforts; further, China was faced with a set of complex political, economic and security interests in dealing with North Korea as it tried to balance its relations with the United States and North Korea. Post 9/11, China has recognised the link between terrorism and the spread and potential use of Weapons of Mass Destruction (WMD). China joined the US sponsored

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10. Elton Gallegly, "Urging the European Union to Maintain its Arms Embargo on the People's Republic of China", *The Library of Congress: Thomas*, Congressional Record 109th Congress: 2005-2006, February 2, 2005, <http://thomas.loc.gov/cgi-bin/query/F?r109:4:./temp/~r109fzkdHp:eO>. Accessed on June 24, 2015.

11. Resolution 1696 called on Iran to suspend all nuclear enrichment-related activities and reprocessing activities, including research and development; or face the possibility of economic and diplomatic sanctions. The resolution also expressed the intention of the UNSC to adopt appropriate measures under Article 41 of Chapter VII of the UN Charter which opens the possibility that force could be used to back up the will of the UNSC, should Iran not comply with the resolution. See Bates Gill, "China's Changing Approach to Non-Proliferation", in Nathan E Busch and Daniel H Joyer, eds., *Combating Weapons of Mass Destruction: The Future of International Non-Proliferation Policy* (Georgia: University of Georgia Press, 2009), p. 251.

Container Security Initiative (CSI) in July 2003 and called for multilateral arms control discussions to address the threat of terrorism and WMD. In October 2002, China further strengthened its chemical export controls by issuing a control list based on the control list used by the Chemical Weapons Convention (CWC). In the area of conventional weapons exports, China had issued its "Regulations on Export Control of Military Items" in October 1997 which became effective in January 1998; in October 2002, it was further revised and listed 183 dual-use technologies that would be subjected to tighter controls and which were also covered in the Wassenaar Arrangement's "core list" of dual-use technologies. It also listed in detail, a set of procedures by which conventional weapons could be exported. In August 2002, the Chinese government published a 24-Article set of missile export control regulations and a related control list; this new document, with some exceptions, had close resemblance to the regulations and technologies covered in the Missile Technology Control Regime (MTCR). In October 2002, Beijing issued regulations and a control list to cover exports of "dual-use biological agents and related equipment and technology". This control list was also in line with the control list issued by the Australia Group (AG). China also became a member of the NSG in the year 2004. Therefore, the new global threat perception post 9/11 led to China undertaking a more constructive policy to ensure global non-proliferation, which has been termed its new security diplomacy that seeks to maintain a stable regional security environment to facilitate its domestic, social and economic development.<sup>12</sup>

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12. Gill, n. 11, pp. 247-255.

## CHINA'S HAND IN NUCLEAR TECHNOLOGY TRANSFER TO PAKISTAN

In July 1968, an intelligence source revealed that Chinese technicians had been allowed to examine the F-104 aircraft provided to Pakistan by the US, at Pakistan's Sargodha Air Base, during which they collected the F-104's spare parts and material samples which were taken back to China for analysis.<sup>13</sup> Later, the same source reported that the Chinese were also allowed to take back a complete F-104 engine, including the internal guide vane part of the fuel control system. According to the report, "...Pakistan's willingness to pass US technology may help to explain Peking's relative generosity to Pakistan..." Furthermore, the report added that China's military assistance to Pakistan had been ongoing since 1965, including military equipment such as the 160 T-59 medium tanks and 124 MIG-19 jet aircraft. As a partial *quid pro quo* for Chinese assistance, Pakistan willingly provided Peking (Beijing) with the US-supplied aircraft technology, violating the terms of acceptance.<sup>14</sup>

On July 14, 1977, the letter from Secretary of State Cyrus Vance to National Security Adviser Zbigniew Brzezinski stated, "...China is not yet involved in foreign nuclear transfers, though it has reportedly told Pakistan it will provide fuel services – but apparently not raw uranium supplies – if all other sources are cut off...." The secretary further added that there were reports that Chinese technicians had arrived at the Karachi Nuclear Power Plant (KANUPP) (heavy water reactor) station in Pakistan to familiarise themselves with the operation of the reactor, and even though the Chinese had no experience with heavy water power reactors or with the techniques of fabricating fuel for them, and a learning period of some duration would necessarily precede the supply of such services. According to Secretary Vance; "...we have, of course, a strong interest in encouraging Chinese cooperation on non-proliferation

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13. George C Denney Jr, "Pakistan and Communist China Strengthen Cooperation", Bureau of Intelligence and Research, US Department of State, *The National Security Archive* (December 4, 1968), <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-2.pdf>. Accessed on June 22, 2015.

14. *Ibid.*

in general, including safeguards as a condition of any supply the PRC might undertake..."<sup>15</sup>.

A 1979, a Central Intelligence Agency (CIA) report to Christine Dodson, National Security Council, referred to the lack of hard evidence to showcase China's involvement in selling and assisting other nations with nuclear technologies which could enable the spread of nuclear capabilities. The report also stated that there was a possibility that China and Pakistan were sharing nuclear weapons-related information. Since the report did not find any hard evidence on these illicit transfers and, at the most, there was only soft evidence available, the claims on China's proliferation remained uncertain. However, these concerns did not go away during the Reagan Administration. While nuclear proliferation was not a top priority, the Administration was apprehensive about the implications of the spread of nuclear capabilities and that China may have been aiding and abetting some potential proliferators by selling unsafeguarded nuclear materials. Furthermore, according to the report, China selling nuclear materials to meet national objectives such as earning hard currency, and flouting international standards, however, did not mean that it was intent upon supporting further nuclear proliferation.<sup>16</sup>

Beijing's official position was that it would not help other countries acquire nuclear weapons. China's professed opposition to sharing nuclear weapons technology with Non-Nuclear Weapon States (NNWS) may have led to a compromise of principles when security and economic interests were at stake. Well before the question of nuclear sharing emerged, China and Pakistan, each having an adversarial relationship with India, had developed a close understanding involving significant military cooperation. When the US cut off sales of weapons to both India and Pakistan because

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15. Cyrus Vance, "Nuclear Safeguards- Pakistan, South Africa, China", Secretary of State Cyrus Vance to National Security Adviser, Zbigniew Brzezinski, *The National Security Archive*, July 14, 1977, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-4.pdf>. Accessed on June 22, 2015.

16. Report by the deputy director for National Foreign Assessment, CIA, to Christine Dodson, National Security Council, "A Review of the Evidence of Chinese Involvement in Pakistan's Nuclear Weapons Program", *The National Security Archive*, December 7, 1979, <http://nsarchive.gwu.edu/nukevault/edd423/>. Accessed on June 16, 2015.

of the 1965 border conflict, China became Pakistan's main supplier of weapons. The close relationship with China became one of the pillars of Pakistan's foreign policy. When India held its first nuclear test in 1974, and Pakistan made the decision to acquire its own capability to build nuclear weapons, it may have seemed a matter of course for elements in the Chinese military, which had a powerful voice in Beijing's nuclear establishment, eventually to decide to lend Pakistan a hand. The interests that propelled Beijing to assist Pakistan's nuclear programme became competitive during the 1980s and 1990s, when other sets of interests were pushing for a stronger Chinese role in global nuclear non-proliferation efforts. Even as reports of Beijing's transfer of nuclear weapons designs and sensitive technologies circulated, the two governments signed a nuclear cooperation agreement and conducted negotiations over the sale of Chinese nuclear reactors.<sup>17</sup>

A cable from the US Embassy in China to the Department of State in 1982, acknowledged the fact that China was assisting Pakistan to develop a nuclear weapon:

....we should leave the Chinese in no doubt that Pakistan's development of a nuclear weapon option would bring into operation US legislation ending military and economic assistance. Quite aside from this, we should point out that movement by Islamabad towards a nuclear explosive potential would ....rather than enhance Pakistan's security.... risking a pre-emptive strike by India and encouraging India to launch an all out programme to develop nuclear weapons. It would destabilise the region and provide Moscow with opportunities to consolidate in Afghanistan and further expand its influence....<sup>18</sup>.

An article to be published in the December 20, 1982 issue of *Newsweek* on Pakistan entitled, "Worries About the Bomb", got the attention of the US Department of State. In a cable to the Embassy of Pakistan on December

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17. William Burr, *China, Pakistan and the Bomb: The Declassified File on US Policy, 1977-1997*, *National Security Archive Electronic Briefing Book, No.114*, March 5, 2004, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/index.htm>. Accessed on June 22, 2015.

18. n.1.

18, 1982, the State Department stated that according to the upcoming *Newsweek* article, nuclear non-proliferation experts had claimed that Pakistan had scoured the world in search of equipment for its reprocessing and enrichment facilities. According to the article, a Pakistani scientist allegedly stole information on uranium enrichment technology from a nuclear installation in the Netherlands. The cable also stated that, according to US official sources, it was believed that China has supplied Pakistan both raw uranium and blueprints for building a bomb.<sup>19</sup>

A 1983 US State Department report titled; "The Pakistan Nuclear Program", gave unambiguous evidence that Pakistan was actively pursuing a nuclear weapon development programme. According to the report; "... Pakistan's near-term goal evidently is to have a nuclear test capability, enabling it to explode a nuclear device if Zia decides it is appropriate for diplomatic and domestic political gains. Pakistan's long-term goal is to establish a nuclear deterrent to aggression by India, which remains Pakistan's greatest security concern...." The report concluded that China had provided assistance to Pakistan's programme to develop a nuclear weapons capability. Over the past several years, China and Pakistan have maintained contacts in the nuclear field. For some time, China's involvement was limited to the operational aspects of the KANUPP power reactor at Karachi. The reports added, "...We now believe cooperation has taken place in the area of fissile material production and possibly also nuclear device design...."<sup>20</sup>.

In March 1988, China had transferred Intermediate Range Ballistic Missiles (IRBMs) to Saudi Arabia; Yang Shang Kun<sup>21</sup> indicated this during his May 1987 visit to the US and added that that China would not sell missiles to any other country besides Saudi Arabia; however, there were

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19. US Department of State, "Newsweek Article on Chinese Nuclear Cooperation with Pakistan", US Embassy Pakistan, Cable 348835, *The National Security Archive*, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-10.pdf>. Accessed on June 23, 2015.

20. US Department of State, "The Pakistan Nuclear Program", *The National Security Archive*, April 16, 1983, <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-11.pdf>. Accessed on June 16, 2015.

21. Yang Shang Kun was the president of China from 1988-1993; prior to this, he was a permanent vice- chairman of the Central Military Commission and was one of the most powerful military figures in China. Yang was closely associated with China's arms sales policies.

**A report submitted by the US under secretary of state for international security affairs on August 24, 1993, stated that China's Ministry of Aerospace Industry and Pakistan's Ministry of Defence had engaged in missile technology proliferation activities that were prohibited to be exported under the MTCR, therefore, violating the 1990 Missile Technology Control Act.**

fears that this technology could be illicitly re-transferred to other states. The meeting brief prepared for President Bush Sr with President Kun highlighted US concerns over the global dangers of nuclear missiles and chemical weapons proliferation. During the meeting, Bush raised concerns on China's assistance to Pakistan's nuclear weapons programme by emphasising that the issue would be a severe burden on the US-China relationship. President Bush hoped that China would work with the US and the international community in seeking to curb the proliferation of ballistic missiles with a range greater than 300 km and a payload greater than 500 kg. According to President Bush, "...the

technology for space launch is similar to that required for ballistic missiles. We are concerned that some nations may be using space programs as a pretext to acquire ballistic missile technology. This is especially troubling when these nations are simultaneously developing chemical weapons. We must assure [ensure] there are safeguards to prevent space cooperation with others from serving such ends..."<sup>22</sup>

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22. US Department of State, "The President's Meeting with President Yang Shangkun", *The National Security Archive*, February 8, 1989, <http://nsarchive.gwu.edu/NSAEBB114/chipak-16.pdf>. Accessed on June 23, 2015.

Act.<sup>23</sup> The Clinton Administration, on August 25, 1993, announced that it would impose sanctions against China for its transfer of M-11 missile parts to Pakistan<sup>24</sup>. These sanctions, unveiled by Under-Secretary of State Lynn Davis, prohibited the export of American satellites to China. This meant that licences would not be given to export to China advanced electronic equipment, technology and equipment for space systems and technology for military aircraft.<sup>25</sup>

The US and most other nuclear suppliers had implemented a full-scope safeguards nuclear export policy and urged China also to adopt such a policy. Wu Chengjiang, first secretary, Ministry of Foreign Affairs, and an expert on nuclear non-proliferation, stated that he was familiar with the issue and with US policy advocating full-scope safeguards for nuclear exports; however, China was not party to such a policy, he said. He pointed out that the NPT, which he stated China would soon ratify, did not require a full-scope safeguards policy. Wu observed that the reactor deal with Pakistan was one that was open, public, and would be subject to IAEA safeguards. He said that China, as a long-time ally and friend of Pakistan, wanted to help Pakistan's economic

**Wu observed that the reactor deal with Pakistan was one that was open, public, and would be subject to IAEA safeguards. He said that China, as a long-time ally and friend of Pakistan, wanted to help Pakistan's economic development and that the reactor deal would benefit both countries.**

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23. Formed in 1987 by the G-7 partners, it consisted of a common export policy applied to a common list of controlled items. The controlled and regulated items include export of missiles, unmanned air vehicles and related technology for those systems capable of carrying a 500 kg payload at least 300 km, as well as systems intended for the delivery of WMD.

24. The sanctions were imposed against two Chinese entities and their subsidiaries and Chinese government organisations involved in development or production of electronics, space systems and military aircraft were also sanctioned like the China Precision Machinery Import-Export Corporation, China National Space Administration, China Aerospace Corporation, China Great Wall Industry Corporation and some other Chinese entities which were subsidiaries of the Chinese Ministry of Aerospace Industry.

25. Nuclear Threat Initiative, "China", <http://www.nti.org/country-profiles/China/delivery-systems>. Accessed on July 5, 2015.

development and that the reactor deal would benefit both countries.<sup>26</sup> As China's market economy developed, greater complexity emerged and the central authorities could not always control events, which is what may have happened when a Chinese firm sold ring magnets used for the production of highly enriched uranium to Pakistan in 1995. During the Clinton years, the *Washington Times* correspondent, Bill Gertz, published highly damaging communication intercepts on Chinese-Pakistan transactions in 1996, causing further concerns amongst US policy makers.<sup>27</sup>

### CHINA'S TECHNOLOGY TRANSFERS TO IRAN

Chinese nuclear cooperation with Iran has always presented a different concern than that raised by Chinese nuclear cooperation with Pakistan. The military-technical relationship between China and Iran, which is over a quarter of a century old, has spawned China's transfers of nuclear weapons, missiles and chemical related technology. Leaked CIA analyses in the mid-1990s reported that China has transferred possibly hundreds of missile guidance systems and computerised machine tools, as well as gyroscopes, accelerometers, and test equipment, all bound for Iran's indigenous missile development programme.<sup>28</sup>

Another case of China's proliferation activity was reported in the media. This related to Iran's test firing of a new low flying cruise missile of Chinese origin, in early 1996. According to US Admiral Redd, the missile was identified as a C-802 anti-ship missile produced by China that was illegally transferred to Iran by the Chinese defence industrial trading companies. The US Administration admitted to the evidence when its Under-Secretary Lynn Davis, on June 19, 1996, told the House International Relations Committee that there was evidence that China had delivered C-802 cruise missiles to Iran. During the Congressional Hearing on the "Review of the Clinton Administration's Non-Proliferation Policy", by the Committee

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26. US Department of State, "China's Nuclear Deal with Pakistan- Demarche Delivered", US Embassy China, Cable 01109, *The National Security Archive* (January 14, 1992), <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-21.pdf>. Accessed on June 23, 2015.

27. Burr, n.17.

28. Gill, n.11.

on International Relations, House of Representatives, on June 19, 1996, committee member Christopher H. Smith (R- New Jersey) termed China as the world's number one proliferator, involved in transferring technology to North Korea as well as to Iran and Pakistan. Smith also pointed out that there was evidence to suggest that North Korea was transferring anti-ballistic missiles to rogue regimes in the Middle East. He also expressed amazement that the Clinton Administration did not levy any sanctions on the Chinese government despite evidence showing that the Chinese government officials knew about, and orchestrated, the transfers of ring magnets to Pakistan which, according to him, would encourage similar deals in the future<sup>29</sup>.

In response, Lynn E. Davis, the then under-secretary of state for arms control and international security affairs, stated that the Clinton Administration "has made non-proliferation one of its highest priorities, and its success is the key to preserving the security of Americans in the post-Cold War world". On China's proliferation, Davis stated that China was committed to carrying out its 1994 commitment to a global ban on sales of MTCR-class ground-to-ground missiles; and that the United States had obtained clarifications and assurances regarding China's nuclear non-proliferation policies, including a significant new public commitment not to provide assistance to unsafeguarded nuclear facilities. China's commitment to this was proven when in the fall of 1995, China suspended its plan to sell Iran two small power reactors due to difficulties in site selection and financing. According to the under-secretary, China's cooperation with Iran appeared consistent with its NPT obligation and the US Administration had no reason to believe that China would knowingly assist Iran to acquire nuclear weapons. Davis further added that the US Administration would continue to oppose the Chinese government's cooperation with Iran's civil nuclear programme, emphasising that such cooperation would help to build a nuclear infrastructure that could assist Iran's acquisition of nuclear

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29. Christopher H Smith, *Review of the Clinton Administration Non-Proliferation Policy: Statement during the Hearing before the Committee on International Relations, House of Representatives*, 104th Congress, 2nd Session, June 19, 1996 (Washington DC: US Government Printing Office), pp. 1-2.

weapons. On the issue of Chinese missile cooperation with Pakistan and Iran, transfers by Chinese entities of dual-use chemicals and equipment that could be used in Iran's chemical programme, and China's transfers of conventional weapons to Iran, the US Administration, she stated, had raised its objection at the very highest levels of the Chinese government and continued to work to prevent these from happening.<sup>30</sup>

In the realm of nuclear technology transfers, according to a 1997 report to Congress on non-proliferation, China's nuclear assistance to Iran has been limited to cooperation in the peaceful uses of nuclear energy and under IAEA safeguards. Nevertheless, because of long-standing US concerns about Iran's intention to develop nuclear weapons, the US believed that any nuclear assistance to Iran, whether or not subject to IAEA safeguards, would help to build infrastructure that would be used by Iran to support nuclear weapons development. For this reason, the US urged China to refrain from nuclear cooperation with Iran. This was a policy adopted by all the other major nuclear suppliers, except Russia and China. The report also suggested that China had provided Iran with four small research reactors and related nuclear fuel. All these reactors and their fuel were subjected to IAEA safeguards and inspected regularly by the IAEA. The reactors were: two sub-critical assemblies—both used natural uranium fuel, one was moderated by light water, the other by graphite; a Zero Power Reactor (ZPR) which used natural uranium fuel and was moderated by heavy water; and a miniature neutron source reactor, which used less than one kilogram of highly enriched uranium. According to the report, none of these reactors posed any direct proliferation risk as they did not produce significant quantities of plutonium. The ZPR and the two sub-critical assemblies, however, could enable Iranian personnel to learn design principles that could have some, albeit marginal, utility in future efforts to design and construct indigenously a larger reactor for plutonium production.<sup>31</sup>

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30. Lynn E Davis, *Review of the Clinton Administration Non-Proliferation Policy: Statement during the Hearing before the Committee on International Relations, House of Representatives, 104th Congress, 2nd Session, June 19, 1996* (Washington DC: US Government Printing Office), pp.4-7.

31. Classified Report to Congress on the Non-Proliferation and Practices of the People's Republic of China, *The National Security Archive*, (1997), <http://nsarchive.gwu.edu/NSAEBB/NSAEBB114/chipak-26.pdf>. Accessed on June 24, 2015.

## CONGRESSIONAL ACTIVISM ON CHINA'S PROLIFERATION IN THE 1990S

A report by the US Office of Technology Assessment submitted to the 100th Congress titled, "Technology Transfers to China", stated that China would become increasingly important to the United States over the next several decades. The US' ability to influence China's growth and influence would be limited since its economic growth is much more dependent on internal Chinese factors than on any US actions, and China will play its international role on the basis of its own perceived best interests. One of the most important influences that the United States has is technology transfers. China recognises the need to acquire new technology and new capabilities in its efforts to modernise and expand its economy. According to the report, China is still a very poor country, and technology transfers can be an important element in humanitarian efforts to help a billion people move out of poverty. America's policy towards China for the past 10 years has been predicated on the assumption that closer relations are generally beneficial, but that caution must be exercised in the transfer of advanced, sensitive technology. The report stated that "...observers feel that US policy has gone too far; that China is a potential adversary, with an alien ideology and an unstable, unpredictable political system. Others see China as a newly industrializing country that is rapidly upgrading its production technology and aggressively seeking international markets, becoming another, potentially much more powerful, Japan or Korea...."<sup>32</sup>.

The report also pointed out that much of China's civilian technology is out of date; as a result, China's Seventh Five-Year Plan (1986-90) aimed for the acquisition of technology as a high priority, especially in the fields of transportation, electronics and computers, telecommunications and energy. Most technology transfer from the United States was from private companies such as General Electric that won two large orders for locomotives, in part for the willingness to transfer the technology of materials and manufacture; American Motors Corporation (AMC) established a joint venture with

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32. US Office of Technology Assessment, "A Report to the 100th Congress titled, Technology Transfers to China", <http://nsarchive.chadwyck.com/nsa/documents/CH/00832/all.pdf>. Accessed on May 20, 2014.

**China's difficulty in assimilating advanced technologies suggested that more could be transferred without incurring much risk that China will use them to produce sophisticated weapon systems, but this risk will grow over the years as China's technological capabilities improve.**

Beijing Automotive Works to produce the AMC's Cherokee model; McDonnell Douglas started co-production of 25 MD-82 twin-jet transport aircraft with the Shanghai Aviation Industrial Corp following the sale of five to China. The US government agencies were also involved in technology transfers as part of an overall effort to cooperate with China and improve relations. The US Office of Technology Assessment reported that these technology transfers could provide some of the keys China needs to meet its modernisation goals.

...Modernization, in turn, will enhance China's position as an exporter and will eventually enhance China's military strength. At present, China's military is large but unsophisticated technologically. There was a concerted opinion that China's military can benefit from foreign technology in three ways: it could buy military technology directly, obtain civilian technology that has military application, or develop its own modern weapon systems as its economy as a whole modernizes...

According to the same report, while it could be reasonably assumed that China's military had access to such technology, till recently, civilian and military enterprises were kept separate, with the military being given priority. The report noted that in the last few years, civilian factories enjoyed an increasing amount of technology transfer and began modernising faster. The report also stated that since modern military systems are complicated and demanding, their manufacturing calls for additional expertise and the availability of precision production equipment and high-quality supplies. Further, China's difficulty in assimilating advanced technologies suggested that more could be transferred without incurring much risk that China will use them to produce sophisticated weapon systems, but this risk will grow over

the years as China's technological capabilities improve. Thus, before the Tiananmen Square event, technology transfers were being contemplated in almost benign terms, with long-term risk assessment. That changed dramatically after 1989 for political and ideological reasons. Further, Congressional concerns became acute as evidence emerged suggesting China's complicity in illegal transfer of technology.<sup>33</sup>

According to William R. Graham, former science adviser to President Reagan and former deputy administrator of the National Aeronautics Space Administration (NASA), China has been one of the major buyers of US surplus military equipment. Further, he added that there existed an atmosphere of pervasive criminality in Russia post the Cold War, coupled with the uncertain future of the Russian economy and government which created an environment in which military hardware and technology flow into the developing world, through both official and unofficial channels, had increased; with several reports showing a very large transfer of SS-18 missile technology to China and also reports of active assistance to the Iranian missile development programme by both Russia and China. China was also involved in government-to-government sales of complete ballistic missile systems that include the sale of the 3,000 km class CSS-2 IRBM systems to Saudi Arabia and the sale of ground mobile M-11 ballistic missiles by China to Pakistan. Graham added that this proliferation in technology could be attributed to the educational opportunities received by foreign (Chinese) students from American universities. According to him, since 1954, there has been a steady increase in the number of foreign students studying at American universities. According to the annual report of the Visa Office of the State Department's Immigration and Naturalisation Service, the number of non-immigrant visas issued in Category F (students

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33. Ibid.

and dependents) since 1984, showed that about 121,952 visas were issued to people from China. Mainland China contributed the highest number of foreign students, a number that has stood consistently at about 10 per cent of all foreign students. Even though the US government does not follow what foreign students are actually studying in the American universities; according to Graham, a visit to the classrooms of leading technical graduate schools suggests that courses in the most advanced aerospace and other related fields of engineering are very popular.<sup>34</sup>

The 1990-96 annual Most Favoured Nation (MFN) status debate provided an occasion for all groups seeking to influence the US-China policy by attaching conditions to MFN status renewal. Congress was particularly concerned with China's proliferation of WMD through the illegal transfer of high-technologies. Policy debates concerning Chinese technology transfers have often centred on the question of whether to impose unilateral sanctions as required by various US laws. While certain Chinese transfers may not violate any international treaties, US non-proliferation policy and enforced non-proliferation treaties and guidelines like the NPT and MTCR impose unilateral sanctions in response to their violations. It is a legal obligation of the executive branch to implement and enforce US laws passed by Congress; they also place a greater priority on non-proliferation as a national interest in view of the strict enforcement of laws for stemming proliferation. On October 30, 1991, the US House of Representatives passed the "Omnibus Export Amendment Act of 1991", one of the major highlights of which, ensured that export licensing preferences in favour of high technology export to China should be eliminated, China's access to dual-use goods and technology should be restricted, and no satellite of US origin that is intended for launch from a launch vehicle owned by China may be exported from the US.<sup>35</sup>

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34. William R Graham, *Missile Proliferation in the Information Age, Testimony during the Hearing before the Sub-Committee on International Security, Proliferation and Federal Services of the Committee on Governmental Affairs, United States Senate, 105th Congress, 1st Session, September 22, 1997* (Washington DC: US Government Printing Office), pp. 9-11 and 14.

35. Shirley A Kan, "China Proliferation of Weapons of Mass Destruction and Missiles: Policy Issues", *Congressional Research Service Report for Congress*, February 8, 2006, <http://fas.org/spp/starwars/crs/RL31555.pdf>. Accessed on July 7, 2015.

Congress passed numerous legislations that provide for unilateral sanctions to be imposed against proliferation. Through these legislations, Congress tried to ensure a safe passage for the transfer of sensitive materials which are dualist in nature. Some of these Acts were the Export-Import Bank Act, Arms Export Control Act, Export Administration Act, Nuclear Proliferation Prevention Act, Iran-Iraq Arms Non-Proliferation Act and Iran Non-Proliferation Act. In early 1996, Congress called for the imposition of sanctions on China after reports came in that it was involved in technology transfers that could lead to the proliferation of WMD. It was alleged that China had sold unsafeguarded ring magnets to Pakistan which was in violation of the NPT and US laws, including the Arms Export Control Act and the Export-Import Bank Act. The Clinton Administration was unable to take a decision on the imposition of sanctions as the trade interests of the US corporations which had business in China made the decision difficult and complicated. The State Department announced that China and Pakistan would not be sanctioned as a result of a new agreement signed between the US and China which stated that China would provide future assistance only to safeguarded nuclear facilities, reaffirming its commitment to nuclear non-proliferation.<sup>36</sup>

The then Chairman of the Senate Committee on Foreign Relation, Jesse Helms, criticised the Clinton Administration for failing to implement a policy to contain the serious proliferation activities of the Chinese and termed the Administration's non-proliferation policies as "*broken promises and worthless pledges*"<sup>37</sup>. The fact that a Republican headed the powerful Senate Foreign Relations Committee after a Democratic rout in the Congressional elections in 1996, compounded the Clinton Administration's difficulties. It also allowed Congress a much more activist and influential role in the policy towards China. Senator John Ashcroft (R-Missouri), during the hearings before the Committee on Foreign Relations, United States Senate, stated that the proliferation of weapons of mass destruction and the technologies that support these are a

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36. Ibid.

37. John Ashcroft, *Proliferation Threats Through the Year 2000: Statement during the Hearing before the Committee on Foreign Relations, United States Senate, 105th Congress, 1st Session, October 8, 1997* (Washington DC: US Government Printing Office), pp. 27-28.

**The senator also argued that once the Chinese obtain US nuclear technology, they would reverse engineer the project, fill their own domestic nuclear energy needs and start competing with US companies in export markets abroad, thereby affecting American business.**

major security threat for the United States. He criticised the Clinton Administration's China policy that favoured nuclear cooperation. This, according to him, was

...political decision driven by the US-China October Summit, rather than by the facts of China's weapons proliferation record. The prospect of nuclear cooperation with China is perhaps the clearest illustration yet of the "trust but don't verify" approach, behind the Administration's China policy....China has a weapons proliferation record unrivalled in the world....has hidden behind non-proliferation

commitments for over a decade.<sup>38</sup>

The senator also argued that once the Chinese obtain US nuclear technology, they would reverse engineer the project, fill their own domestic nuclear energy needs and start competing with US companies in export markets abroad, thereby affecting American business.

Senator Cochran (R-Mississippi), who was the chairman of the US Subcommittee on International Security, Proliferation and Federal Services of the Committee on Governmental Affairs, during the Congressional hearing on proliferation and US export controls on June 11, 1997, stressed on the need for a reexamination of American export control practices, especially with respect to goods having both military and civilian applications, or commonly referred to as dual-use goods. In his opening statement, Senator Cochran stated that in the latter stages of the Cold War, approximately \$100 billion per year worth of exports required an export licence; however, in 1996, the Commerce Department licensed for export \$ 4.9 billion worth

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38. *Ibid.*, pp. 27-28.

of dual-use technology, while America's total export volume of goods and services amounted to \$ 846 billion, therefore, the licensed exports comprised just under six-tenths of one per cent of total US exports in 1996.<sup>39</sup> Senator Cochran also stated that along with President Clinton's policy to liberalise American export controls, there should also be appropriate provisions in place to ensure that no retransfer of dual-use technology towards other illicit activities occurs, as this would not only lead to weapons proliferation but also bring about cheaper alternatives into the market that could edge out American manufactured goods and, thereby, affect American commerce. Senator Cochran also stated that, in the case of supercomputers, based on the testimony by Secretary Reinsch during the hearing held by the House of Representatives in April 1996, 46 American supercomputers were in the People's Republic of China, at least one of which was sold to the Chinese Academy of Sciences by Silicon Graphics. According to Senator Cochran, the Chinese Academy of Sciences is a key participant in Chinese military research and development, and has been, for a long time, working on the DF-5 Intercontinental Ballistic Missile (ICBM), which is capable of reaching the United States. Other activities of the academy included uranium enrichment for nuclear weapons. This, according to the senator, is a result of a flawed US export control policy.<sup>40</sup>

**Senator Cochran also stated that, in the case of supercomputers, based on the testimony by Secretary Reinsch during the hearing held by the House of Representatives in April 1996, 46 American supercomputers were in the People's Republic of China, at least one of which was sold to the Chinese Academy of Sciences by Silicon Graphics.**

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39. Through this figure, Senator Cochran wanted to throw light upon the need to strengthen America's export control which did not cover many of the export items, some of which were dualistic in nature, and also wanted to stress on the need to make these controls more stringent since more than 95 percent of the export licences requests were being approved without much investigation.

40. Thad Cochran, *Proliferation and US Export Controls, opening Statement made during the Hearing before the US Senate, Sub-Committee on International Security, Proliferation and Federal Services of the Committee on Governmental Affairs*, 105th Congress, 1st Session, June 11, 1997 (Washington DC: US Government Printing Office), pp. 1-2.

Seth W Carus, a visiting fellow at the National Defence University, in a testimony before Congress in 1997, stated that one of the major concerns with regard to China was that it continued to refuse to abide by its commitments to adhere to the international norms to which it is a signatory such as the MTCR.<sup>41</sup> As a result, despite the US receiving assurances from the Chinese government that it would end its missiles export and adhere to the principles given in the MTCR, it has been found that China has repeatedly broken its commitments.<sup>42</sup>

A report to Congress by the Department of Defence in accordance with Section 1306 (c)<sup>43</sup> of the Annual National Defence Authorisation Act (NDAA)<sup>44</sup> for the fiscal year 1997, stated that China's state owned entity, the China Nuclear Energy Industry Corporation, transferred ring magnets to an unsafeguarded uranium enrichment facility in Pakistan.<sup>45</sup> In 1999, US-China relations took a hit when the *New York Times* reported that China had stolen the designs of the most advanced US nuclear warheads. This story was based on leaks from a special investigative committee in the US House of Representatives, chaired by Representative Christopher Cox (R- California). This committee was investigating charges that critical US technology had been transferred to China by major US corporations while using Chinese

41. Carus also added that under the MTCR, it was agreed not to transfer complete ballistic missiles and cruise missiles systems that exceed certain capabilities and to control the export of certain technologies needed to produce ballistic or cruise missiles. Therefore, the MTCR has an important role in slowing down the spread of ballistic missiles technologies.

42. Seth W Carus, *Missile Proliferation in the Information Age, Testimony during the Hearing before the Subcommittee on International Security, Proliferation And Federal Services of the Committee on Governmental Affairs, US Senate, 105th Congress, 1st Session, September 22, 1997* (Washington DC: US Government Printing Office), p. 20-24.

43. The NDAA for the fiscal year 1997, in which under Title XIII- Arms Control and Related Matters; Subtitle A: Arms Control, Counter-Proliferation Activities and Related Matters. Section 1306 (c) requires the presidential report regarding weapons proliferation and policies of the People's Republic of China.

44. The NDAA is a United States federal law specifying the budget and expenditures of the United States Department of Defence. The US Congress oversees the defence budget primarily through two yearly Bills: the National Defence Authorisation Act and Defence Appropriation Bill. The Authorisation Bill determines the agencies responsible for defence establishment funding levels, and sets the policies under which the money will be spent. For further details see, URL:[http://en.wikipedia.org/wiki/national\\_Defense\\_Authorization\\_Act](http://en.wikipedia.org/wiki/national_Defense_Authorization_Act).

45. The action by the Chinese entity was in conflict with China's obligations under Articles I and III of the NPT, as well as the official non-proliferation policies and assurances by the PRC and Pakistan with respect to the non-proliferation of nuclear weapons and nuclear-capable missiles.

rockets to launch US satellites. The Cox Committee Report suggested that American technology and production processes transferred to China for civilian uses were being diverted to military end users, particularly in the high-performance computer, guidance, encryption, jet engine and precision machine tool areas.<sup>46</sup>

On May 25, 1999, the Cox Committee released the declassified version of its January 3, 1999, classified report on its investigation of US technology transfers to China. The committee, after lengthy investigations, concluded that over the last 20 years, China had pursued a serious effort to acquire advanced American technology, making it a major threat for the American national security. US Congressman Doug Bereuter (R-Nebraska) who was a part of the Cox Committee, while addressing the speaker of the House on July 19, 1999, emphasised on the truly bipartisan nature of the Cox Committee and stated that the findings in the report were fully corroborated with evidence. The Congressman stated that during the course of their investigation, they had come across far more disturbing information, one being the very institutional problem that existed in the federal agencies and, in particular, in the Department of Energy (DOE). The Congressman stated, "...I believe that these lapses of security at the DOE weapons laboratories taken together resulted in the most serious espionage loss and counterintelligence failure in American history. Moreover, these lapses facilitated the most serious theft ever of sensitive US technology and information..." The committee made 38 recommendations for remedies, including possible legislation to tighten export controls and provide greater security to the national labs. According to Bereuter, most of the recommendations could be implemented by the executive branch without legislation, such as increasing the penalties for export control violations.<sup>47</sup>

During the 106th Congress, the issue of China's proliferation of weapons resurfaced with reports in June 2000 stating that China was aiding Pakistan's missile development programme. Representative Frank

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46. J Cirincione, J Wolfsthal and M Rajkumar, *Deadly Arsenal: Tracking Weapons of Mass Destruction* (Washington DC: Brookings Institution Press, 2002), pp. 169-170.

47. Doug Bereuter, *An Accurate Reading of the Cox Committee Report*, 106th Congress, July 19, 1999, <http://fas.org/sgp/news/1999/07/bereuter.html>. Accessed on July 6, 2015.

Pallone (D- New Jersey), wrote to President Clinton on July 5, 2000, urging him to immediately impose sanctions on China. Speaking to the House, Pallone stated that he was encouraged to see that the Administration had dispatched a top arms control official to Beijing to address the growing concerns about China's proliferation activities. However, the concerns remained, as the State Department's Senior Adviser on arms control, John Holum stated, "... we made progress, but the issue remains unresolved..." to the *New York Times* on July 9, 2000. Congressman Pallone also stated that the Chinese support for Pakistan's missile development programme was a matter of concern for the United States and for the long-term stability of the entire Asian continent.<sup>48</sup>

On November 21, 2000, the Administration imposed sanctions on Pakistan for engaging in missile technology proliferation activities with China. On May 22, 2002, in the House of Representatives during the 107th Congress, Representative Pallone (D- New Jersey), stated that China, despite entering into an agreement with the Clinton Administration in November 2000, which prohibited transfers of missiles or missile technology to Pakistan, continued missile technology transfers. The Congressman voiced his concerns about the Bush Administration waiving off a substantial amount of missile technology control regime sanctions that were imposed by the Clinton Administration under S-1465, which provided the president with increased flexibility in the exercise of his waiver authority with respect to Pakistan. Representative Pallone also wrote to President Bush on this issue on May 22, 2002, in which he strongly urged the president to reconsider the termination of the sanctions on missile technology transfers from China to Pakistan. Pallone also cited the probability of Osama bin Laden and members of the Al Qaeda getting access to these deadly arsenals which would be catastrophic.<sup>49</sup>

The dawn of the new millennium also brought in new challenges, Robert

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48. Frank Pallone, "Concerns of Chinese Aid for Pakistan Ballistic Missile Program Still Unresolved", The Library of Congress Thomas, Congressional Record 106th Congress: 1999-2000, July 11, 2000, [http://thomas.loc.gov/cgi-bin/query/D?r106:1:./temp/~r106WSVP24:.](http://thomas.loc.gov/cgi-bin/query/D?r106:1:./temp/~r106WSVP24:) Accessed on June 25, 2015.

49. Ibid.

Sutter argues that the 107th Congress (2001-02) that coincided with the start of the Bush Administration, resulted in a decline in the scope and intensity of the domestic American debate over the China policy. The partisan attacks on the US Administration's engagement policy towards China diminished as the White House and Congress both were controlled by the Republican Party leadership, which intended to show unity and party discipline on sensitive issues, including the China policy. Furthermore, the US preoccupation with the "War on Terror", including the US led military attacks on Afghanistan and Iraq, made it more difficult for US interest groups and other activists to gain the public and private attention in Congress and elsewhere that they seemed to need in order to press for changes in US policies towards China<sup>50</sup>.

Post 9/11, with the US engagement on the "Global War on Terror" and with China stepping up to assist, the US called for a special relationship with China in the 108th Congress. As a result of the US Administration's "War on Terror", it found itself engaging with China which also found favour with Congress and, thus, the enhancement of the relations with the enactment of the US-China Engagement Act in the year 2006. After Bush introduced the US-China Engagement Act in April 2006, Senator Mark Steven Kirk (R- Illinois), while introducing the Act in the House of Representatives on April 26, 2006, stated,

...The US China Engagement Act is an important step in addressing the most critical relationship of the 21st century.... We must be prepared diplomatically, educationally and economically.... This Bill will give American students and American businesses the tools to compete in the new and expanding market of China....<sup>51</sup>.

Despite Congressional concerns and actions, the Administration, engulfed with the "War on Terror" and military operations in Iraq and

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50. Robert G. Sutter, *US-Chinese Relations: Perilous Past, Pragmatic Present* (Maryland: Rowmen and Littlefield Publisher Inc, 2010), p. 127.

51. Mark Steven Kirk, *Introduction of US-China Engagement Act*, 109th Congress, April 26, 2006, <http://www.congress.gov/cres/2006/04/26/CREC-2006-04-26-pt1-PgE624-2.pdf>. Accessed on July 6, 2015.

**On the flip side, it has resulted in China growing in stature, and as it grew through its illicit ways of selling technologies to other nations and, in turn, also enhancing its own capabilities, it could be inferred that the US Administration has failed to ensure that China's actions found stronger US reactions.**

Afghanistan, and with the increasing vested economic interest with China, felt the need to continue engaging with China, hence, overlooking all its acts of violations in the realms of not only proliferation of weapons but also in human rights violations and trade.

#### **CONCLUSION**

Since 1996, China has increased its defence budget by more than 10 percent in real terms every year, except in 2003. The pace and scope of China's military build-up already puts regional military balances at risk. China is likely to continue

making large investments in high-end, asymmetric military capabilities, emphasising electronic and cyber warfare, counter-space operations, ballistic and cruise missiles, advanced integrated air defence systems, next generation torpedoes, advanced submarines, strategic nuclear strike from modern, sophisticated land and sea-based systems; and theatre unmanned aerial vehicles for employment by the Chinese military and for global export. However, post-Cold War US policy has remained focussed on encouraging China to play a constructive, peaceful role in the Asia-Pacific region and to serve as a partner in addressing common security challenges, including terrorism, proliferation, narcotics and piracy. US policy sought to encourage China to choose a path of peaceful economic growth and political liberalisation, rather than military threat and intimidation.<sup>52</sup> On the flip side, it has resulted in China growing in stature, and as it grew through its illicit ways of selling technologies to other nations and, in turn, also enhancing its own capabilities, it could be inferred that the US Administration has failed to ensure that China's actions found stronger US reactions. Therefore, this

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52. Anthony H Cordesman, *Salvaging American Defence: The Challenges of Strategic Overstretch* (Washington DC: Centre for Strategic and International Studies, 2007), pp. 426-427.

pattern of invoking US actions such as sanctions against China's activities in the realms of proliferation of weapons in the 1990s became a mere formality in the US Congress that used it as an incentive to lock horns with the Administration and show its discontent. Furthermore, actions imposed were also withdrawn in a timely manner, leading to a vacuum in the US' China policy which enabled its growth.

US-China relations that made headway during the Nixon Administration as part of the US Cold War grand strategy have continued to sustain despite various events that not only complicated the relationship but also caused serious concerns within the United States about China's intentions. Strong voices from the general public, humanitarian and other interest groups as well as strong voices within the US Congress, called for stringent action against China. However, it was found that the relationship continued and evolved into a much deeper and strategic one. It is this continued engagement policy in the pursuit of economic and strategic goals by successive US Administrations that has enabled and fuelled China's growth over the last few decades. This paper has looked into one of the major dimensions of China's illicit activity that has dominated the headlines since the 1980s, which is in the realm of nuclear weapons proliferation. The issue of China's non-obligation to, or non-compliance with, the international non-proliferation treaties to which it was a signatory should have called for strong action by the US Administration. However, it was found that a stream of continuity in the relationship remained, as the US Administration wanted to keep the line of communication open and not undo decades of diplomatic efforts. Hence, Beijing not only continued to engage in illicit activities by transferring sensitive technologies, but also through covert activities in the West, it was able to fuel its own aspirations of building a modern military warfare system. This has helped the spread of weapons, including nuclear

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capabilities, in India's neighbourhood and become a serious security concern that has enveloped the entire South Asian region. It is also a major cause of concern for contemporary global security since these technologies have been retransferred to other "rogue" states. Lax controls over these sensitive technologies and materials could eventually lead to non-state actors gaining access to them and pose a serious international problem.

# CYBER ATTACKS VIA HARDWARE EXPLOITATION: AN INSIDIOUS AND ELUSIVE MENACE

ASHISH GUPTA

At the heart of the ubiquitous internet and incessantly active cyber space, which sets in motion, and sustains, the momentum of the juggernaut of modern times, is a complex set-up of micro-processing chips. These chips, hidden from the functional, resplendent and vibrant exterior of the cyber world, act as arteries, intricately entwined and woven, and provide it with the necessary sustenance and subsistence. Microchips are the bedrock upon which the digital world has been conceived, nurtured and developed to become an all encompassing entity providing the yarn for weaving the fabric of modern society. The micro-electronics industry, the manufacturer and supplier of hardware capability, drives the anthropocentric nature of cyber space and provides technical scaffolding to achieve greater penetration of the digital services and media in societal interactions and functioning.

The invention of the first Integrated Circuit (IC) in 1958 by Jack Kilby of Texas Instruments,<sup>1</sup> marked the beginning of the age of the microchip. These early chips consisted of a few transistors, diodes, resistors and capacitors placed onto a slice of germanium and linked by gold wires, and were exorbitantly priced. In over a decade, microchips have become the foundation for the realm of high speed computing. Intuitively realising

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1. Walt Kester, *The Data Conversion Handbook* (Massachusetts: Elsevier, 2005), p.259.

**Armed with the power of the internet, with ingenious and experimental methods, cyber criminals have leveraged vulnerabilities, loopholes, technology shortcomings and glitches, back doors, gullibility of users for financial frauds, identity thefts, theft of state secrets and corporate espionage.**

the characteristics and dimensions of this development, in 1970, Gordon E. Moore, almost prophetically described the relationship between the growth of processing power and the increased capacity of microchips. The iconic Moore's Law states that the overall processing power for computers will double every two years.<sup>2</sup> In other words, the number of transistors on a Central Processing Unit (CPU) would double every two years. In 2000, the number of transistors in the CPU numbered 37.5 million, while in 2009, the number went up to an outstanding 904 million.<sup>3</sup>

The growth and proliferation of micro-processing chips pose a new kind of challenge, further exacerbating the chaos to the already tumultuous field of cyber security. Armed with the power of the internet, with ingenious and experimental methods, cyber criminals have leveraged vulnerabilities, loopholes, technology shortcomings and glitches, back doors, gullibility of users for financial frauds, identity thefts, theft of state secrets and corporate espionage. The coalescence of criminal intent and technology has added another vulnerability dimension to the rapidly expanding repertoire of cyber crime and espionage activities. In the ongoing contest between cyber security enforcers and cyber criminals, new tools, techniques and methodologies are ever evolving and are limited only by technology, imagination and ingenuity. A new cyber threat, looming large over the industry, military and critical infrastructure is purposeful manipulation of processing chips during the manufacturing process to provide remote access or take control of a system to shut it down, to steal data or to corrupt it. The acts of cyber crime have reached pandemic proportions worldwide and are causing colossal financial losses, erosion

2. Moore's Law, "How Overall Computing Power of Computers Will Double Every Two Years," <http://www.moorelaw.org/>. Accessed on July 30, 2015.

3. Ibid.

of reputations and loss of intellectual property. While software security rules the roost as a deterrent and for prevention of breaches of cyber security, hardware security has not been accorded the requisite importance and has generally been relegated to a footnote rather than being assimilated as a core subject in any debate on cyber security.

Since the early 1980s, from just a handful of known companies and even fewer chip designers, the microchip industry has made great strides commensurate with the advances in design and fabrication and ever-increasing worldwide demand for sophisticated chips. Today, to keep pace with demands and to reap commercial gains, these companies are collectively creating more than 5,000 new designs each year.<sup>4</sup> These companies have spread their Research and Development (R&D) operations and production across the globe in various countries, based on business opportunities and commercial imperatives as well as the availability of a pool of skilled labour. The design and post design fabrication of these chips have become so intricate and complex that efforts to understand every detail of their architecture overwhelms human intelligence and diligence. These developments, from the perspective of growth and penetration of computer devices, mobile phones and other net enabled devices, are positive and empowering. New manufacturing processes, adoption of new technology and global competition have brought down the cost while adding higher processing power. However, the associated complexities of chips and globally distributed design teams have proportionally increased the opportunities to embed hidden malicious functionality in the chips.<sup>5</sup>

A modern large chip can be subjected to fast automated testing methods

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4. US Committee on the Offshoring of Engineering, *Facts, Unknowns, and Potential Implications* (National Academies Press), p.169.

5. John Villasenor, "Compromised By Design? Securing the Defense Electronics Supply Chain," Executive Summary, Centre for 21st Century Security and Intelligence at Brookings, November 2013.

to carry out a functionality test, but even this will give inconclusive results as the fastest automated testing would take years to simulate each and every task a chip is capable of performing. Nowadays, modern chips are tested using statistical techniques, in which random samples are subjected to random inputs, and the results are inferred as statistically probable. The statistical model is effective in indentifying the design flaw. However, intentionally introduced design flaws are much harder to find as these may contain a latent functionality that may be triggered after months or years and will remain invisible during testing.

Those who were buoyed by the availability of rather inexpensive highly sophisticated and easily programmable micro chips have been rudely shaken by the episodes and instances of deliberate insertion of malicious functionality in the micro-chips and their exploitation. A detailed examination and analysis of recent major cases will provide an understanding of the severity and consequences of hardware-level vulnerabilities' exploitation.

- In 2011, a small US company was able to win the contract for the supply of more than US\$15.8 million in computer parts to various US government organisations, including the US Navy. Many of the electronic items were labelled as "military-grade" and destined for use in advanced fighters, radar systems, and missiles. It was later learned that almost all of these parts were manufactured in China at a single factory, using inferior and recycled materials. The products bore the false markings of well-known chip-makers such as Intel, Texas Instruments and Motorola.<sup>6</sup> Though the bulk of the counterfeit parts was seized and impounded, those which remained in use posed a wide range of existential risks of equipment damage, personal injury and possible death due to malfunction at a critical juncture. The Naval Air Systems Command, without addressing whether some of the counterfeit chips remained in use or circulation, had warned that any failures had the potential to ground military aircraft or prompt mistaken shoot-downs of friendly planes.<sup>7</sup> In order to fathom the monumental impact these counterfeit chips had on national security,

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6. "Counterfeit Chips Plague Pentagon Weapons Systems ", <http://www.publicintegrity.org/2011/11/07/7323/counterfeit-chips-plague-pentagon-weapons-systems>

7. Ibid.

investigators at the US Government Accountability Office (GAO), posing as chip brokers, successfully purchased counterfeit circuits from Chinese suppliers that were labelled for use in military systems. It was also reported by GAO that:

- Counterfeit routers with high failure rates had been sold to the US Navy,
- Counterfeit microprocessors had been sold to the air force for use on F-15 flight control computers,
- Oscillators with a “high failure rate” had been sold by a prohibited supplier for use by thousands of air force and navy navigation systems. These failures “could prevent some unmanned systems from returning from their missions,”<sup>8</sup>
- The Electronic Warfare (EW) suite of the F-35 strike fighter uses industry-standard Field Programmable Gate Arrays (FPGAs) to simplify integration and future evolution.<sup>9</sup> A field-programmable gate array is an IC that can be programmed in the field after manufacture. A single FPGA can replace thousands of discrete components by incorporating millions of logic gates in a single IC chip. More than three-quarters of these field programmable gate arrays in the F-35 strike fighter are made in China and Taiwan.<sup>10</sup> If the hardware of these chips is subtly modified to escape detection during quality checks, a trigger, at a later chosen time, to extract tactical or strategic advantage, can effectively degrade or disable the chips and the systems that depend on these. It is also possible to implant an internal time bomb during the inception stage of the chip to trigger a shutdown at someone’s date and time of choosing.
- In 2011, when Huawei and ZTE, the top two Chinese telecommunications equipment manufacturers sought to market their equipment to the US telecommunications infrastructure, the House Permanent Select Committee on Intelligence initiated investigations to inquire into the

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8. United States Government Accountability Office, *DOD Should Leverage Ongoing Initiatives in Developing Its Program to Mitigate Risk of Counterfeit Parts*, Belva Martin (Washington D.C.: Government Printing Office, 2010), p.9.

9. “F-35 Electronic Warfare Suite: More Than Self-Protection”, [http://www.aviationtoday.com/av/military/F-35-Electronic-Warfare-Suite-More-Than-Self-Protection\\_845.html#.VNrV5ctO7ug](http://www.aviationtoday.com/av/military/F-35-Electronic-Warfare-Suite-More-Than-Self-Protection_845.html#.VNrV5ctO7ug)

10. P W Singer, “Hacked Hardware Could Cause the Next big Security Breach”, *Popular Science*, March 2015.

**The committee concluded that risks associated with Huawei's and ZTE's provision of equipment to US critical infrastructure could undermine core US national security interests. In the report, it was also unambiguously stated that "when those companies seek to control the market for sensitive equipment and infrastructure that could be used for spying and other malicious purposes, the lack of market diversity becomes a national concern for the United States and other countries."**

counter-intelligence and security threats posed by these companies doing business in the United States. The committee concluded that risks associated with Huawei's and ZTE's provision of equipment to US critical infrastructure could undermine core US national security interests.<sup>11</sup> In the report, it was also unambiguously stated that "when those companies seek to control the market for sensitive equipment and infrastructure that could be used for spying and other malicious purposes, the lack of market diversity becomes a national concern for the United States and other countries."<sup>12</sup> Some of the concerns stem from the past affiliations of Huawei's founder, Ren Zhengfei. Although the company is selectively mute about his background, some information

garnered from other sources indicates that Ren Zhengfei attended the Chongqing University of Civil Engineering and Architecture and served in the People's Liberation Army's (PLA's) engineering corps, reportedly in its information technology research unit. He rose to the position of deputy director but without a military rank. He left the army and moved to Shenzhen, where he set up Huawei in 1987. Though Huawei has projected itself as a company with an explicit commercial intent, the former association of its founder with the PLA and Huawei's refusal to provide details on its R&D programmes and other documents undermine its claim of not working in collusion with the Chinese military or intelligence services. The intelligence community is abuzz with speculation that there

11. US House of Representatives 112th Congress, *Investigative Report on the US National Security Issues Posed by Chinese Telecommunications Companies Huawei and ZTE* (2012).

12. *Ibid.*, p.2.

is more to Huawei's rise than innovation and technology breakthroughs. It is widely believed that its expansion is attributable to a heavy subsidy by the Chinese government, eager to use it as a Trojan horse for infiltration into more and more foreign networks.<sup>13</sup>

- In the year 2007, the Taiwanese Investigation Bureau found that out that Maxtor portable hard discs produced by Seagate Technology for sale in Taiwan contained Trojan horse viruses. The Investigation Bureau said the tainted portable hard drives automatically uploaded any information saved on the computer to Beijing websites without the user's knowledge. It was speculated that deliberate "contamination" was introduced when the products were with Chinese sub-contractors during the manufacturing process.<sup>14</sup>
- At one time, the powerful but surprisingly cheap Chinese-made Android Star N9500 Smartphone was considered a sterling example of the Chinese ability to provide state-of-the-art gadgets at surprisingly low prices. Little did the consumers know that this was being used to distribute a dangerous factory-installed Trojan, until discovered by the German security firm, G Data. It allegedly contained the Uupay D Trojan, embedded and disguised as the Google Play Store app. G Data's Christian Geschkat revealed, "Unfortunately, removing the Trojan is not possible as it is part of the device's firmware and apps that fall into this category cannot be deleted. This includes the fake Google Play Store app of the

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13. "Huawei : The Company that Spooked the World," *The Economist* , August 4, 2012, <http://www.economist.com/node/21559929>.

14. "Chinese Subcontractors Blamed for Trojan Horses," *Taipei Times*, December 11, 2007, <http://www.taipeitimes.com/News/taiwan/archives/2007/11/12/2003387447>

N9500.”<sup>15</sup>

- Since mid-2013, the US National Security Agency (NSA), in the garb of national security, embarked on a mass surveillance programme codenamed the “PRISM program”. The scope, magnitude and technological sophistication required for the programme was colossal even by American standards. The offshoot of the PRISM programme was a repertoire of sophisticated digital tools as listed in the “NSA ANT Catalogue”. The catalogue bears testimony to the notorious credentials of the US intelligence agency to spy on its targets. “The leaked NSA ANT Catalogue is a 50-page document created in 2008. Its list goes like a mail-order catalogue of digital tools, from which the employees of NSA can order technologies from the ANT division to use against its targets. The Advanced/ Access Network Technology (ANT) division is part of the NSA’s Tailored Access Operations (TAO) Department and they are specialized in covert data-mining and data-skimming operations, especially on specific difficult targets.”<sup>16</sup> The range of digital tools developed by ANT uses seemingly innocuous and ubiquitous digital devices such as monitors, mobile phones, cables, USBs, routers, servers, etc. The nightmarish reality became all too pronounced with the knowledge that these products were implanted in the most widely used US brands around the world like Apple, Cisco, Dell, Juniper Networks, Maxtor, Seagate, and Western Digital.<sup>17</sup> In spite of formal denials issued by these companies, there is little doubt that their devices were used by the NSA for digital eavesdropping for covert espionage purposes.

## UNDERSTANDING CHIP BUILDING ECOSYSTEM

During the nascent growth of the semi-conductor industry, all the requisite tasks that went into making a chip, ranging from specification, design,

15. “Chinese Star N9500 Android Smartphone Contains Factory-Installed Trojan, says Security Firm”, <http://www.techworld.com/news/security/chinese-star-n9500-android-smartphone-contains-factory-installed-malware-says-security-firm-3525608/>

16. Jacob Appelbaum, et. al., “Die Klemmer aus San Antonio”, *Der Spiegel*, January 2014.

17. Jacob Appelbaum, et. al., “Shopping for Spy Gear: Catalog Advertises NSA Toolbox”, *Spiegel Online International*, December 29, 2013, at <http://www.spiegel.de/international/world/catalog-reveals-nsa-has-back-doors-for-numerous-devices-a-940994.html>. Accessed on July 30, 2015.

manufacturing and testing were undertaken by a single company. Some of the companies still operate in this manner. However, in chip manufacturing, as *functionality and complexity* increased, the costs of building manufacturing facilities went up exponentially. In late 2012, it was reported that the South Korean Electronics giant Samsung Electronics Co. Ltd. would spend US\$ 7 billion on a NAND flash wafer fab (fabrication) in Xian, a city in the northwest of China.<sup>18</sup> In research conducted by Gartner, Inc., it was projected that the “costs of manufacturing equipment will drive the average cost of semiconductor fabs to between 15 billion US dollars and 20 billion US dollars by 2020.”<sup>19</sup> The prohibitive high costs in having one’s own manufacturing capability have spurred the growth of external manufacturing companies. These external facilities known the “foundries” for manufacturing semiconductor devices, facilitate a semi-conductor company to function and grow with limited resources and capital, without investing heavily in the manufacturing process. In the semi-conductor manufacturing realm, the design and sale of semi-conductor chips while outsourcing the fabrication is termed as ‘fabless’ manufacturing. In the year 2012, out of 50 top semi-conductor companies, 13 were ‘fabless’ including Qualcomm, Broadcom, AMD and Nvidia. In 2013, revenue of as much as US\$ 78.1 billion came from the fabless IC business and the top 13 foundries accounted for 91 percent of total foundry sales. Out of these 13 foundries, five are Taiwanese while two are Chinese.<sup>20</sup> Overall, the five Taiwanese foundries secured about 60 percent of the global market last year. The remaining 40 percent went to three South Korean companies (Samsung Electronics Co, Dongbu Electronics and Magna Chip Semiconductor), two Chinese companies (Semiconductor Manufacturing International Corp and Hua Hong Grace Semiconductor Corp), two US (Global Foundries and IBM Corp) and one Israeli chipmaker,

18. EET Asia, “Samsung Plans \$7B NAND Fab in China,” [http://www.eetasia.com/articleLogin.do?artId=8800664879&fromWhere=/ART\\_8800664879\\_499486\\_NT\\_f709dbeb.HTM&catId=499486&newsType=NT&pageNo=null&encode=f709dbeb](http://www.eetasia.com/articleLogin.do?artId=8800664879&fromWhere=/ART_8800664879_499486_NT_f709dbeb.HTM&catId=499486&newsType=NT&pageNo=null&encode=f709dbeb). Accessed on July 30, 2015.

19. Gartner, “Market Trends: Rising Costs of Production Limit Availability of Leading-Edge Fabs”, <https://www.gartner.com/doc/2163515/market-trends-rising-costs-production>. Accessed on July 30, 2015.

20. Bill McClean, “Top 13 Foundries Account for 91% of Total Foundry Sales in 2013,” *IC Insights Research Bulletin*, January 28, 2014, <http://www.icinsights.com/data/articles/documents/640.pdf>. Accessed on July 30, 2015.

**What appears to be a sound business strategy is a real challenge for national security due to lack of trustworthiness and quality assurance for components, which might find their way into critical military and infrastructure applications.**

TowerJazz Semi-conductor, among others.<sup>21</sup> Today, the IC design continues to be the fastest growing segment of China's semi-conductor industry. In a decade from 2003 to 2013, China's IC design industry has grown from US\$ 541 million to record revenues of US\$ 13.2 billion in the year 2013, with an impressive 33 percent growth rate.<sup>22</sup> Similarly, during the past ten years, the top Chinese semi-conductor companies have grown from 26 companies with average revenues of US\$ 39 million to 50 companies

with average revenues of US\$226 million.<sup>23</sup>

The microelectronics industry restructuring has seen horizontal consolidation through elimination of redundancies and capitalisation of synergies, replacing the vertically integrated structure which was slackening the pace of innovation. This restructuring is also driven by the commercial imperative of spreading the capital risks over multiple stakeholders. What appears to be a sound business strategy is a real challenge for national security due to lack of trustworthiness and quality assurance for components, which might find their way into critical military and infrastructure applications. Trustworthiness includes the confidence that the classified or mission-critical information contained in the chip designs is not compromised, the reliability is not degraded and unintended design elements are not inserted in the chips.<sup>24</sup>

Another dimension, which adds more complexity to the debate, is that the weapon systems and military hardware are designed, produced and

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21. Kevin Chen, "Powerchip Gains in Foundry, TSMC Still First," *Taipei Times*, February 5, 2014, <http://www.taipeitimes.com/News/biz/archives/2014/02/05/2003582752>. Accessed on July 30, 2015.

22. Raman Chitkara, "A Decade of Unprecedented Growth China's Impact on the Semiconductor Industry 2014 Update," *PwC*, August 2014, <http://www.pwc.com/gx/en/technology/chinas-impact-on-semiconductor-industry/assets/2014-section-2.pdf>

23. *Ibid.*

24. US Defence Science Board, Dr. William Howard et al., *Report on Defense Science Board Task Force on High Performance Microchip Supply* (Washington D.C. :Government Printing Office, 2005),p.3.

procured based on their envisaged final capability, range, endurance, firepower and sophistication. The acquisition process of military hardware does not include detailed specifications for components; rather, it focusses on achievable functionality as per the specifications. A military system is made up of various sub-systems designed to carry out a specific task and the individual circuits in the sub-system are mostly fabricated with commercially available ICs. These ICs are procured from the global marketplace, partly due to the cost factor and partly due to copyrights issues. It, therefore, becomes vital to ensure that defence systems and mission-critical products are designed and procured with appropriate oversight and controls to ensure their mission functionality and operational availability at all times.

**But, as with all technological advancements, its all encompassing penetration and integration into all the facets of social, financial and military activities, brings to the fore the associated challenges, including new vulnerabilities, new attack vectors and perhaps most concerning of all, an almost innate ability to use remote access to cause physical destruction.**

#### **CHALLENGE OF UNBRIDLED PROLIFERATION OF IOT DEVICES**

The rapid influx of smart, adaptive, and connected devices—the “Internet of Things” (IoT)—virtually across all sectors, is happening at a speed that far outpaces earlier technological developments. The development of IoT is directly linked with accrument of significant societal benefits through enhanced efficiencies, improved reliability and resilience, prompt medical care, detection of faults, and more. But, as with all technological advancements, its all encompassing penetration and integration into all the facets of social, financial and military activities, brings to the fore the associated challenges, including new vulnerabilities, new attack vectors and perhaps most concerning of all, an almost innate ability to use remote access to cause physical destruction. In its report, the US National Security Telecommunications Advisory Committee (NSTAC) described

IoT as an expansion of the global infrastructure through existing and evolving interoperable information and communication technologies that incorporate the interconnection of physical and virtual systems to enable new and automated capabilities.<sup>25</sup> The rapid and unhindered growth of IoT will witness an exponential expansion in attack surfaces due to increased dependencies, the vast number of devices and associated interconnections and the changed threat landscape, with existential and potential increase in kinetic-focussed cyber attacks.

- **By 2020, it is estimated that 50 billion devices will be connected to the internet.**<sup>26</sup> These devices will exchange massive amounts of data and as technical sophistication improves, these devices will be able to make intelligent decisions autonomously and will share information via embedded machine-to-machine communications with other internet-capable devices.<sup>27</sup> The defence industry is probably the harbinger of this revolution and had been at the forefront in development and adoption of IoT before it gained momentum as a commercially viable and technologically workable system. The tactical data is being shared among a number of platforms-planes, ground vehicles, ships, spacecraft and weapon systems which have been networked. At this stage, the types and quantum of vulnerabilities likely to emerge due to IoT dependence **will be speculative, and the challenges to rein in the cumulative impacts due to exploitation of such vulnerabilities will increase.**
- Irrespective of the use and the users of IoT devices, the thread of commonality among all the devices will be their irrevocable dependence on microchips. A deliberate attempt to make a chip function in an unintended fashion poses unfathomable risks. For an individual, the risk may be trivial, ranging from irritation to inconvenience. The scenario will be much more frightening when evaluated over the whole spectrum of IoT services. IoT health care devices, including implantable ones,

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25. National Security Telecommunications Advisory Committee, *Report to the President on the Internet of Things*, DHS-2014-0048 (Washington D.C. : Government Printing Office, 2014), p.1.

26. Dave Evans, "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything", *CISCO White Paper*, April 2011, [https://www.cisco.com/web/about/ac79/docs/innov/IoT\\_IBSG\\_0411FINAL.pdf](https://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf). Accessed on July 30, 2015.

27. Ibid.

for example, will have built-in connectivity and if compromised to malfunction, could lead to patient deaths. In January 2014, the Director of US National Intelligence (DNI) stated before Congress that in “the cross-networking of personal data devices, medical devices, and hospital networks, cyber vulnerabilities might play unanticipated roles in patient outcomes.”<sup>28</sup> The encroaching inroads made by IoT will make personal privacy a thing of the past. The potential national security implications that could arise from the compromise or malfunction of IoT devices embedded in different critical infrastructure systems will be of enormous proportions. Many of the present critical infrastructures are made up of automated and adaptive devices, incessantly collecting and analysing data and then making automated decisions.

Ameliorating the threats emanating from malicious exploitation of vulnerabilities in hardware, introduced deliberately or discovered by serendipity, requires multi-pronged approaches. From a national security-standpoint, manufacturers and suppliers with a high trust quotient must exclusively be entrusted with the responsibility of supplying the hardware. Trust cannot be added to integrated circuits after fabrication; electrical testing and reverse engineering cannot be relied upon to detect undesired alterations in military integrated circuits.<sup>29</sup> An equally important and **far-reaching safeguard against such threats is to dispense with dependence on** off-shore manufactured microelectronic components and rely on in-house expertise to fulfil the needs of ICs, microelectronic components and microchips across the whole spectrum of electronic and microelectronic technologies. In the Indian context, in spite of the country’s proven technological prowess and enviable pool of highly qualified, talented professional, the road to realisation of these objectives is not without challenges. Some of these are;

- The production of custom-made hardware components with unique

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28. US Department of National Intelligence, James R. Clapper, *Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence*, Statement for the Record (Washington D.C. :Government Printing Office, 2014), p.3.

29. n.24, p.3.

**In India, at present, approximately 65 percent of the demand for electronics products is met by imports, which is likely to grow from US \$28 billion in 2011 to US \$ 42 billion this year. The government has instituted a number of policies aimed at holistic development of the Electronics System and Design (ESDM) industry and fostering the growth of the Indian electronics ecosystem.**

functionalities is not commercially viable. The incentives to rope in capital and resources for manufacturing of specific to requirement ICs in limited numbers are inadequate and insufficient. Besides, the chip design ecosystem has become much more globalised and complicated and is driven by economic imperatives, competitive markets, competent and adaptable workforce and demand-based production. Efforts to establish manufacturing pockets of ICs isolated from the global ecosystem will become a formidable challenge and will not accrue proportionate benefits in the long run.

- Even if the requirement of trusted hardware devices is fulfilled by government owned or operated facilities

specifically set up for this, keeping pace with technology evolution and maintaining a competitive parity will not be easy. The cost of keeping such facilities perennially near to the state-of-the-art commensurate with their private counterparts, will be prohibitively high. Besides, in response to the demands for new features and capabilities, these facilities will find themselves inadequately equipped or on the verge of technological obsolescence.

In India, at present, approximately 65 percent of the demand for electronics products is met by imports, which is likely to grow from US \$28 billion in 2011 to US \$ 42 billion this year.<sup>30</sup> The government has instituted a number of policies aimed at holistic development of the Electronics System and Design (ESDM) industry and fostering the growth of the Indian electronics

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30. India Electronic & Semiconductor Association, "Indian ESDM Market: Analysis of Opportunity and Growth Plan, An IESA - Frost & Sullivan Report", available online at <http://www.iesaonline.org/downloads/IESA-FS-report-Indian-ESDM-Market.pdf>

ecosystem. The government instituted National Policy on Electronics (NPE) aims to create an ecosystem for a globally competitive ESDM sector by attracting investments of about US \$ 100 billion and generating employment for around 28 million people at various levels.<sup>31</sup> The policy also aims for the Indian ESDM sector to develop core competencies in strategic and core infrastructure sectors like telecommunications, automobiles, avionics, industrial, medical, solar, information and broadcasting, railways, intelligent transport systems, etc.

## CONCLUSION

The ever changing landscape of the threat ecosystem calls for innovative, proactive and dynamic posturing and preventive and migration strategies with specific regard to technological changes and developments. The existing governmental support, policy formulation and industry outlook towards reducing off-shore dependency and achieving self-reliance in indigenous designing, fabrication and production of semi-conductor devices are sincere and well-founded. However, the global competitiveness, fuelled by technological advances and sweeping innovations, is hindering the prospect of a fully self-reliant ecosystem capable of catering to the myriad requirements of military hardware. Besides, the overdependence on exports of military hardware from a wide range of defence equipment suppliers, spread across many countries, is a major roadblock in the realisation of this objective. The foreign suppliers are either not mandated to provide the details of microchips or are reluctant to part with this information to thwart emulation/ imitation efforts by the process of reverse engineering. At times,

**The foreign suppliers are either not mandated to provide the details of microchips or are reluctant to part with this information to thwart emulation/ imitation efforts by the process of reverse engineering. At times, even the identification marks on these chips are erased or deliberately etched away to make even recognition an impossible task, let alone functionality determination.**

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31. Ibid.

even the identification marks on these chips are erased or deliberately etched away to make even recognition an impossible task, let alone functionality determination.

Hence, there is a need to strengthen existing awareness and training programmes among all the stakeholders to widen their understanding of the possible risks and vulnerabilities associated with hardware devices. Role-specific responsibilities must be clearly laid down for those involved in the design, production, procurement, and operation of military hardware. A mission critical device must be checked for the whole range of possible functions by way of simulation. The integration of collaborative engagements between the government and industry, leveraging of industry capabilities and academia's expertise and insight are some of the measures capable of ameliorating the threat emanating from hardware vulnerabilities.

# DEVELOPMENT OF THE AEROSPACE INDUSTRY IN US AND USSR/RUSSIA

VIVEK KAPUR

## INTRODUCTION

Research efforts into the science of fluid dynamics by the Europeans such as Otto Lilienthal, Sir George Cayley and Daniel Bernoulli, amongst others, led to the development of the science behind aviation<sup>1</sup>. This science led to less scholarly but more technically and mechanically minded men attempting to apply the new theory to practice towards the development of mankind's first heavier than air flying machines, capable of carrying human beings aloft<sup>2</sup>. These efforts bore fruit with the Wright Brothers' flight of 12 seconds duration over 120 ft on December 17, 1903, at Kitty Hawk, in Flyer 1, ushering in the aviation age.<sup>3</sup>

## US AEROSPACE INDUSTRY

The US stole a lead over Europe in conducting the first documented flight of a heavier than air aircraft despite the theory behind heavier than air flight being primarily European in origin. Inadequate investment and lack

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1. Johan Hoffman, Johan Jansson and Claes Johnson, "The Secret of Flight", pp.293-330, <http://www.csc.kth.se/~cgjoh/ambsflying.pdf>. Accessed on June 24, 2015.
2. Ibid., pp.295-330.
3. Eyewitness to History.com, "The Wright Brothers First Flight, 1903", <http://www.eyewitnesstohistory.com/wright.htm>. Accessed on June 21, 2015.

**The active involvement of private companies that were the driving force behind these achievements can be attributed in part to their attempts to win government support, including funding, and to obtain firm orders for their aircraft designs from potential customers.**

of government support for aviation in the US<sup>4</sup> thereafter resulted in Europe regaining the lead towards newer developments and advancements in aircraft technology, spurred on, as the Europeans then were, by the pressing demands and necessities of total war during World War I. In 1913, the US Army Air Corps (USAAC) had just six active pilots and the whole of the US had less than 170. When the US started its active participation in World War I in Europe, American pilots flew primarily British and French designed and built aircraft due to the lack of suitable high performance American aircraft.<sup>5</sup>

#### *Development of US Aviation Companies*

Not forced to divert resources towards the war on the scale that the Europeans were, US *private entrepreneur promoted companies* (emphasis intended), led by Glen Hammond Curtis, James Smith McDonnell, and Donald Wills Douglas,<sup>6</sup> amongst others, established the US industry on its own feet, leading to landmark achievements such as the first trans-Atlantic flight by the US Navy flying boat NC4 and the first trans-global flight by the Douglas world cruisers.<sup>7</sup>

These achievements were also spurred on by the demands of the US government and military for ever more capable aircraft to be designed and built for specific national requirements. The active involvement of private companies that were the driving force behind these achievements can be attributed in part to their attempts to win government support, including

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4. what-when-how.com, "Aerospace Industry, US", <http://what-when-how.com/flight/aerospace-industry-u-s/>. Accessed on June 23, 2015.
  5. Geaviation.com, "Aviation History", <http://www.geaviation.com/company/aviation-history.html>. Accessed on June 22, 2015.
  6. Information from web page [http://en.wikipedia.org/wiki/McDonnell\\_Douglas](http://en.wikipedia.org/wiki/McDonnell_Douglas). Last accessed on September 3, 2015.
  7. Air Mrshl SR Deshpande, *Aerospace Industry* (New Delhi: Manas Publications, 2004), pp. 25-28.

funding, and to obtain firm orders for their aircraft designs from potential customers. Throughout the process of carrying out ever longer duration flights, the potential military applications of the technologies and techniques being developed were not lost on the US government and its armed forces. The wide publicity accorded to the new records being set in aviation also led to a situation of ever more aircraft design and building companies being started by skilled entrepreneurs.

In the early years of modern aviation, aircraft design and construction was considered more of an art and skill than a science. This view was supported by the large number of aircraft manufacturing companies that came up in the US in the early 20th century, despite a total lack of any specific formal training for aircraft design and construction at the time. What almost all these companies had in common was that they were established, and led, in the most part, by brilliant designers who included such famous names as Jack Northrop, who established the Northrop Corporation in 1939, the brothers Allan and Malcom Loughhead, who later changed their family name to Lockheed and founded the Loughhead Aircraft Manufacturing Company, later called the Lockheed Corporation, Glen Hammond Curtiss, founder of the Curtiss-Wright Corporation, James Smith McDonnell and Donald Wills Douglas, founders of the McDonnell Aircraft Corporation, and Douglas Aircraft Company respectively, to name a few.

General Electric (GE) Corporation in the US responded to a US government requirement and contract from the US National Advisory Committee on Aeronautics (NACA) for the development of a turbocharger for aircraft engine application in 1915-17; the successful demonstration of the

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GE turbocharger device saw it being utilised from 1918 onwards to improve altitude performance of existing aero-engines in the USAAC inventory.<sup>8</sup> From this humble beginning, GE went on to develop ever more capable power plants for aviation applications. Towards the end of World War II, it became clear that the US was lagging behind England and Germany in engine technology as both these countries had already deployed jet engines in service while the US still utilised high performance piston engines. GE thereafter successfully made the transition from piston engines to jet engines, with the help of some friendly access to British technology provided by the British government, and continues to make cutting edge jet engines for civil as well as military applications even today.<sup>9</sup> Alongside Pratt and Whitney, GE is one of only two<sup>10</sup> designers and manufacturers of high performance jet engines in the US today.<sup>11</sup> More than half of the US led coalition aircraft deployed in “Operation Desert Storm”, for the Gulf War of 1991, flew with GE engines.<sup>12</sup> In 2003, as many as 80 percent of US led coalition aircraft deployed for “Operation Iraqi Freedom” used GE engines.<sup>13</sup>

The American aircraft industry started to develop through private entrepreneurs building aircraft to meet the US Army’s military requirements initially for primarily scout or reconnaissance machines. Military requirements slowly expanded to include fighter, bomber, and transport aircraft also. The Wright Brothers, despite their much touted first flight, were unable to compete effectively and other designers took the lead in designing and building practical machines that were usable in real world conditions. The commencement of World War I, soon after the invention of the aircraft, led to the output of aircraft from American aircraft factories

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8. Kimble D. McCutcheon, “The First Turbosupercharged US Aircraft Engine”, <http://www.enginehistory.org/superchargers.shtml>. Accessed on July 1, 2015.

9. Geaviation.com , n.2..

10. Modern jet engines continue to be very difficult technology to master. Despite decades of experience, the US has just two high performance jet engine makers, GE and Pratt & Whitney; Western Europe too had just two: Rolls Royce and SNECMA. The USSR/ Russia have Saturn NPO, Klimov, Turmansky, Kuznetsov, Soloviev and Lyulka.

11. Nish Amarnath, “World’s Top 3 Jet Engine Makers Exploit Booming Airline Market”, *International Business Times*, July 10, 2012, <http://www.ibntimes.com/worlds-top-3-jet-engine-makers-exploit-booming-airline-market-722046>. Accessed on June 27, 2015.

12. n.2.

13. Ibid.

increasing rapidly. However, the lack of cutting edge performance from these aircraft resulted in the American World War I pilots who took part in operations against Germany, flying French and British designed and built aircraft. The American designed and built aircraft did help to widely popularise aviation as a viable activity and also served effectively in the pilot training role, especially in the years after World War I.<sup>14</sup> The large scale production of these aircraft helped build up the capabilities of American aircraft companies in manufacturing skills and also led to the development of several innovations that helped establish a few companies firmly in the aircraft design and building field. The transition of viewing aircraft design and manufacture as a science and not an art or craft commenced in the 1920s and was supported by Research and Development (R&D) establishments in the US and in Europe.<sup>15</sup>

Designers such as Curtiss designed and built effective light aircraft that were adapted to the air-to-air fighter aircraft role. The worth of military aviation was proved during World War I and the importance of military aviation was pushed further by aviation champions such as Brig Giulio Douhet in Italy, Brig "Billy" Mitchell in the US, and Air Mshl Hugh Trenchard in Britain, amongst others. In the years leading up to World War II, US aircraft companies such as Boeing, Lockheed, Douglas, McDonnell, North American, and Grumman established themselves as major operators in the designing and building of aircraft. These companies, despite the slow and steady growth of civil aviation, relied primarily on military orders for their sales volumes and financial survival.<sup>16</sup> In fact, a few of these US aviation firms dealt almost exclusively with the military<sup>17</sup>.

Several of these American aircraft firms established in the early years of the 20th century are in operation even today, close to a century later. The aviation innovator, the company set up by the Wright Brothers, failed to compete effectively. Companies such as Boeing, and Lockheed, etc. moved

14. Ibid. what-when-how.com, "Aerospace Industry, US", <http://what-when-how.com/flight/aerospace-industry-u-s/>. Accessed on June 23, 2015.

15. Rosa Maria Moller, Ph.D, "Aerospace States' Incentives to Attract the Industry", California Research Bureau (CRB) 08-005, May 2008, California Research Bureau, California State Library.

16. n.4.

17. Ibid.

ahead while the Wright Brothers' company was bought out a few years later by the Curtiss Aeroplane and Motor Company to form the Curtiss-Wright Corporation. Later entrants were able to build up a strong foundation on the errors and learning of the early entrants and innovators to build up viable capabilities at sustainable cost-profit ratios and, thus, build technologically and economically viable businesses that have stood the test of time and are viable, going concerns, even today, a century later.

The interest of the US military in an effective aviation arm led to demands for greater performance and ruggedness from new military aircraft. The large number of aircraft manufacturers promoted competition to win the lucrative military contracts. Heavy investment was required in R&D of new materials, design and construction techniques and component parts and technologies. By the beginning of World War II, the US had a robust aircraft industry that was turning out a large number of aircraft for different requirements. While the American aircraft lacked in pure performance over their European and Asian counterparts such as the British Spitfire, the German Messerschmitt Me-109, and the Japanese Mitsubishi A6M "Zero"<sup>18</sup>, in the early years of World War II, the US, backed by its massive resources, maintained an advantage in numbers to enable it to hold its own till it could catch up technologically. The later introduction of the US Lockheed P-38 "Lightning" and the North American P-51 "Mustang" gave the US military fighter aircraft that could outperform any aircraft produced in England, Germany, the Soviet Union, and Japan. In 1944, there were 300 companies operating in the aircraft and aircraft component supply business, with 66 aircraft building plants in the US, employing 1.6 million workers. A mere year later, there were just 15 companies with a total of 16 plants and 138,700 employees<sup>19</sup>!

The post World War II years saw an inevitable scaling down of production of aircraft, putting the US aircraft industry through a stressful

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18. Larry Dwyer, "Mitsubishi A6M Reisen (Zero-Sen)", <http://www.aviation-history.com/mitsubishi/zero.html>. Accessed on July 3, 2015.

19. Jorge Niosi, in his presentation at the DIME / Catching Up Conference, Milan, December 10-11, 2009.

period. The earlier investments in large production facilities for the large war-time production orders led to idle facilities and underemployed or unemployed skilled workers with major aircraft manufacturers in the post war years. This situation was mitigated by the commencement of the Cold War. The Cold War forced the US to develop and build military hardware on a scale that, though not as massive as during World War II, was still quite respectable. The Soviet Union, the US' rival during the Cold War, had an advantage over the US and its allied forces in numbers, backed by an industrial philosophy of rapid construction of very large numbers of relatively simple and rugged machines. The US government relied upon advanced technology to counter the Soviet Union's larger numerical strength. This requirement led to the US military demanding very advanced performance from the aircraft designers in the US. Such demands led to expensive and intense R&D effort into new cutting edge technologies by US aircraft companies. The performance of the resultant aircraft exceeded anything built hitherto, though these, at times, fell short of the most demanding US military requirements in performance. Cases of the initial performance parameters of aircraft not fully meeting the requirements of the US military led to a planned programme of progressive and continuous improvements being initiated, in consultation and agreement with the US end user, the US Air Force (USAF). This process involved induction into service of the baseline aircraft. Then, in a planned manner, these inducted aircraft were to be upgraded, as and when the required fixes for performance shortfalls became available, to reach, in a progressive manner, the final performance demanded by the USAF. Through initiating a steady process of incorporating improvements in the concerned aircraft, the needs for high performance were met while keeping the R&D, design and production expertise and skills intact. The financial future of the aircraft and component parts manufacturers was also protected through adoption of this system, especially as the US establishment realised that these personnel and facilities would be required in the future also and so it had a vested interest in ensuring their survival. The cutting edge nature of the aircraft, which consistently incorporated several new,

**The risk for most aircraft companies now became the fear of political considerations leading to project cancellations after large sums of money had been spent on R&D for a project. Availability of the best research facilities and brains to the aircraft companies meant that technological challenges were less of a problem in most cases.**

very advanced, and unique, 'nice to have' technologies, produced by the US in the second half of the 20th century, resulted in an exponential increase in the cost of these machines. The high costs were exacerbated by the aviation companies' practice of paying their personnel extremely high salaries and bonuses in appreciation of the efforts put in by them. A quick look at the average salaries in the US' aerospace and defence industry follows later in this paper. These problems of ever increasing costs of developing and manufacturing aircraft and associated equipment led in time to the government putting in place a system to monitor the companies more closely, with

an aim of controlling the spiralling costs of equipment. The risk for most aircraft companies now became the fear of political considerations leading to project cancellations after large sums of money had been spent on R&D for a project. Availability of the best research facilities and brains to the aircraft companies meant that technological challenges were less of a problem in most cases.<sup>20</sup> The major pressures on aircraft and associated technology companies now became not the development of the aircraft or weapon system with the required performance, but obtaining an adequately large production run to recoup the development costs and to obtain the desired profits. This requirement came at a time when the US military started placing orders for significantly fewer numbers than it had earlier.<sup>21</sup> The US order numbers reduction was a function of more capable aircraft being able to do more, thus, lesser numbers being able to deliver the results required, and the effects of higher prices per unit in a time of inelastic procurement budgets.<sup>22</sup> US aircraft companies were,

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20. Ibid.

21. Ibid.

22. Ibid.

thus, forced to look for export orders to retain profitability. The fact that the US government was reluctant to allow unfettered exports of advanced American weaponry due to the security implications of the latest American weapons falling into the hands of the Soviets meant that even exports required a number of government clearances. Several US aircraft companies resorted to underhand methods to obtain export orders. Notably, Lockheed Corporation is known to have indulged in widespread bribery both in the US and abroad in order to win adequate export orders for its F-104 "Starfighter" fighter aircraft<sup>23</sup>. The Northrop Corporation was similarly cited for having resorted to bribery to obtain sales for its F-5 "Tiger" fighter.<sup>24</sup> Boeing was infamously involved in a major domestic scandal when a former Pentagon official, Ms. Darleen A. Druyun, who oversaw contracts worth \$23 billion for In-Flight Refuelling (IFR) aircraft being awarded to Boeing, was hired by the company after she retired from her government job, at very high compensation, as an apparent pay-off for earlier favours concerned with the Pentagon's procurement contracts.<sup>25</sup> The desperation to secure sales and stay afloat in an expensive business comes through very clearly in these publicly known cases of the largest and most 'respectable' US aerospace companies having been involved in major unethical activities.

**The desperation to secure sales and stay afloat in an expensive business comes through very clearly in these publicly known cases of the largest and most 'respectable' US aerospace companies having been involved in major unethical activities.**

World War II had showcased the importance of rocket technology in modern warfare. Hence, the US military, in the post World War II years, started to devote considerable effort in rocket development, with contracts for development of effective long range rockets being issued to companies

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23. W.H.Hartung, *Prophets of War* (New York: Nation Books, 2012), pp.131-132.

24. n.14.

25. Jerry Markon and Renae Merle, "Ex-Boeing CFO Pleads Guilty in Druyun Case", *Washington Post*, Tuesday, November 16, 2004; page E01, <http://www.washingtonpost.com/wp-dyn/articles/A51778-2004Nov15.html>. Accessed on July 4, 2015.

involved till that time in aircraft design and production. While rockets were developed for use as surface-to-surface ballistic missiles, their utilisation to access outer space began to be debated. Theorists also examined the potential national security utilisation of space and the new term “aerospace” came to be coined as an amalgamation of air and space technology and operation. The rocket development effort was helped in large measure by the US capture of significant German personnel and documentation on rocket technology, and several German war-time rockets of various types, including the liquid fuelled 500 mile range ballistic trajectory Nazi V-2 weapon, for examination and reverse engineering. In the early years, the Soviet Union was able to steal a lead over the US, as demonstrated by its being the first to put an artificial Earth satellite into orbit in 1957<sup>26</sup> followed by the first human being to go into space in 1961.<sup>27</sup> In response, the US launched a massive focussed space technology development programme. Expertise was rapidly built up and the aerospace industry emerged from the earlier aircraft industry.<sup>28</sup> At first, government contracts to different suppliers obtained different major parts of aerospace systems for assembly at government controlled facilities. Later, single point orders were given to one major aerospace company. This company would then order sub-parts from sub-contractors, assemble the final product and deliver it to the arm of the government that had ordered the item in the first place. This latter system proved to be more efficient and practical in terms of costs incurred as well as the quality of the product and on time delivery. The prime contractor or assembler carried overall responsibility to the ordering agency for all aspects, including managing the sub-contractors.<sup>29</sup> Over time, this system has come to be adopted by ever increasing parts of the US aerospace industry. The first US programme to use this system was the Minuteman missile project that used Boeing as the

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26. Nasa.gov, “Sputnik and the Dawn of the Space Age” ,<http://history.nasa.gov/sputnik/>. Accessed on August 20, 2015.

27. Nola Taylor Redd and Robert Roy Britt, “Yuri Gagarin: First Man in Space: The Greatest Moments in Flight”, <http://www.space.com/16159-first-man-in-space.html>. Accessed on August 20, 2015.

28. n.14.

29. Ibid.

prime contractor.<sup>30</sup> From the 1950s, the major US aircraft companies had started to steadily increase the share of missiles in their business portfolio from a paltry 5 per cent to 44 per cent by 1960.<sup>31</sup>

Civil aviation also played a major role in the US aerospace industry's development. This sector was spurred on by the newly affluent US population's desire for air transport services. McDonnell Douglas, Boeing and Lockheed were the most active airliner builders in the US. Financial woes forced McDonnell Douglas to be bought out by Boeing. Problems with the L-1011 Tri-Star and Electra aircraft at the same time as issues were being faced with military aircraft developments such as the C-5 "Galaxy" heavy transport aircraft forced Lockheed to abandon its airliner business, in large part due to the support available to the military business from the USAF and Pentagon, with no such support available in the civil field, and concentrate only on military aircraft.<sup>32</sup>

### *Government Influence and Support to US Aerospace Industry*

The US government realised the importance of aviation technology for the prosperity and security of the country quite early and, as a result, in 1915, established the NACA. The NACA was tasked to explore the science behind aviation with the aim of discovering new insights that could benefit American aviation. Research and developments by the NACA were the property of the US government. However, these were made available either free or at very nominal cost to US aircraft companies. Some noteworthy early contributions from the NACA included streamlined shapes to reduce drag, aerofoil sections for various applications, optimum engine nacelle design, etc.<sup>33</sup> This enabled the aircraft companies to capitalise on the development R&D effort put in by the US government for practical application. In this manner, the US government fully supported its national aviation industry. After World War II, the NACA developed designs for supersonic flight and

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30. n.14.

31. Ibid.

32. Hartung, n.23.

33. Elizabeth Suckow, "National Aeronautics and Space Administration, History", last updated on April 23, 2009 <http://history.nasa.gov/naca/overview.html>. Accessed on July 2, 2015.

was involved in the design of the X-1 that carried 'Chuck' Yeager to speeds beyond Mach 1.0. The area rule concept was also a contribution of NACA R&D.<sup>34</sup> In 1958, the NACA was reorganised as the National Aeronautics and Space Administration (NASA) and all the responsibilities of the NACA, in addition to space research and exploration fell under the ambit of the new organisation.<sup>35</sup> The trend of the US government carrying out or sponsoring high end scientific research in aerospace science and technology, and making the results available to its private sector aerospace companies, continues even till date. In a capitalist country and economy, this is a rare example of institutionalised state support to private industry. The apparent incongruity of the US government's support to private industry becomes easier to understand in the context of the US' clear understanding that its domestic aerospace industry is an essential component of its national power in the economic, military and technological domains and, hence, essential for the country to maintain its relevance and prime position on the global stage.

The US aerospace industry comprised 2.8 percent of the US manufacturing workforce in year 2008. The aerospace industry contributed \$57.7 billion to the US trade balance, with aerospace exports to Europe and other allies globally totalling up to \$ 95 billion in the year 2008.<sup>36</sup> In the year 2008, the US aerospace industry accounted for 1.4 percent of the US Gross Domestic Product (GDP) compared to 1.5 percent in the year 2000 and 1.7 percent in the late 1990s.<sup>37</sup> US aerospace manufacturers depend heavily on exports for their sales.<sup>38</sup>

### *Attraction for Skilled Workforce*

The US aerospace industry has been built upon the base of a highly educated and suitably skilled workforce.<sup>39</sup> These basic skills and knowledge built

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34. Ibid.

35. Ibid.

36. Michaela D. Platzer, "US Aerospace Manufacturing Industry Overview and Prospects", Congressional Research Service, 7-5700, December 3, 2009, [www.crs.gov](http://www.crs.gov), R40967. Accessed on July 5, 2015.

37. Ibid.

38. Ibid.

39. Deloitte, "The Aerospace and Defense Industry in the US: A Financial and Economic Impact Study", [http://www.aia-aerospace.org/assets/deloitte\\_study\\_2012.pdf](http://www.aia-aerospace.org/assets/deloitte_study_2012.pdf). Accessed on June 28, 2015.

up in the population have enabled the US to develop and build a robust aerospace industry that for several decades has enabled its participants to earn wages well above the national average.<sup>40</sup> The high wages earned by aerospace industry workers have helped set up a cycle of these well-paying jobs, motivating more people to build up the knowledge and skills required to enter the industry as effective participants. The US aerospace industry employed 458,525 people in the year 2005, increasing to 480,668 people in the year 2010.<sup>41</sup> The US aerospace and defence industry directly employed 1.005 million people in the year 2005 and 1.05 million people in the year 2010.<sup>42</sup> The total aerospace and defence industry payroll in the year 2010 in the US amounted to \$84.2 billion and the average wages in the aerospace and defence sector were \$80,175 in the year 2010 when the average national wage in the US was \$ 44,410.<sup>43</sup> The large numbers of people employed in the aerospace and defence industry and the total payroll of these personnel helps bring out the importance of this industry for the security and economy of the US. The fact that the robust US aerospace and defence industry had sales revenue in the year 2010 of \$324 billion<sup>44</sup> brings out that the aerospace industry can contribute considerably to the GDP of a country. In the year 2010, the US aerospace and defence industry contributed foreign sales, hence, exports, of \$89.6 billion.<sup>45</sup>

### *US Government Support for Development of a Viable Aviation Industry*

The US government has, at times, actively supported the private aerospace companies apparently to encourage healthy competition among these for government and private contracts. The apparent aim has been to pit one company against another to develop advanced cutting edge capabilities for the US military. The US also often carried out development programmes that involved government funding for R&D activities in private companies. Depending upon the circumstances, a few of these deals involved the

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40. Ibid.

41. Ibid.

42. Ibid.

43. Ibid.

44. Ibid.

45. Ibid.

**The US government utilised a wide variety of means to encourage cutting edge R&D to enable its armed forces to field the very latest and futuristic aerospace equipment. The US set up the Defence Advanced Research Projects Agency (DARPA) in 1958 to specifically explore new technological concepts and to oversee their development and operationalisation in concert with US institutes of higher learning, government owned facilities and private industry.**

government bearing all costs of the R&D while, at other times, the government and the concerned private companies shared the costs and risks in a pre-determined ratio, and, at times, the private company bore the entire cost of R&D, apparently with the surety that if the technology proved successful, the company would have assured orders in a near monopolistic situation, with attendant high profits.

In the 1970s, in view of the Vietnam War experience, the USAF came up with a requirement for a Light Weight Fighter (LWF) able to engage, and win against, the latest Soviet fighters exemplified by the Soviet MiG-19, MiG-21 and their successors. The LWF programme saw the Northrop Corporation entering its YF-17 "Cobra" design against the General Dynamics YF-16. The USAF chose the YF-16 as the winner and this aircraft entered USAF service as the F-16 "Fighting Falcon". The YF-17 was later developed by Northrop, in close collaboration with McDonnell Douglas Corporation, for aircraft carrier-based use as the F/A-18 "Hornet" in the US Navy (USN) service and with the US Marine Corps (USMC). The Fifth Generation Fighter (FGF) competition, called the Advanced Tactical Fighter (ATF) programme in the US, to develop a new fighter able to defeat the Soviet SU-27 and MiG-29 then under development, saw both Boeing and Lockheed competing through developing their own concepts for a high performance Low Observable (LO) fighter, the YF-23 and YF-22 respectively. After evaluation by the USAF, the Lockheed entry, the YF-22, was chosen to enter USAF service as the F-22 "Raptor". Thus, the US government utilised a wide variety of means to encourage cutting edge R&D to enable its armed forces to field the very latest and futuristic

aerospace equipment. The US set up the Defence Advanced Research Projects Agency (DARPA) in 1958 to specifically explore new technological concepts and to oversee their development and operationalisation in concert with US institutes of higher learning, government owned facilities and private industry. This model is of interest in view of the obvious results that it has delivered over the past several decades. On examining any discrete time block since the advent of aerospace technology, the US is seen to possess higher capabilities than any other nation state or alliance in the aerospace field. In later years, the striking similarity of new technology and knowhow used on aircraft from different manufacturers in the US also indicates the dissemination of advanced knowledge from a central source to many operators. The General Dynamics YF-16 and McDonnell Douglas YF-17 demonstrator aircraft taking part in the USAF Light Weight Fighter (LWF) competition both featured the then new technology of sharp Leading Edge (wing) Root Extensions (LERX) and highly blended wing fuselage design, pointing towards the benefits of such features having been proven by a central research agency and shared for actual implementation with aircraft design and building companies, in view of the fact that the chances of separate entities, working in widely separated locations, coming out with such similar new design features at the same time, are quite remote. In fact, the US system of tasking two separate companies to develop prototypes for a new weapon system and then going for a face-off / fly-off to select the better or more suitable weapon system commenced in the years after World War II, and continued till very recently when the prohibitive costs and losses incurred by the company that failed to qualify for a firm contract made it no longer feasible. The Joint Strike Fighter (JSF) F-35 "Lightning-II" project did not see two competing designs being evaluated, as the cost of R&D was seen to have risen to the extent

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that the loser in such a competition would be forced to declare bankruptcy and close shop. Hence, a single vendor situation was accepted as the only option. NASA, however, still remains engaged in high end R&D alongside DARPA to conceive of, and promote, development of the next generation of equipment for aerospace applications in pursuit of the US' national security. The US model described above could find application in other countries.

The US government has been remarkably tolerant of failures, time and cost overruns in advanced weapon system development projects. This is despite at least some information on cost and time overruns leaking to the media and receiving wide publicity, and undergoing scrutiny by US civil society as well as groups with vested interests, not the least of which is the political opposition in the US legislature and civil society led by a number of Non-Governmental Organisations (NGOs).

Recent trends in the aerospace industry, not just in the US, but elsewhere also include what could be called the 'merger mania' at both prime contractor and component supplier levels.<sup>46</sup> Thus, since the 1990s, Boeing bought out McDonnell Douglas while Martin of Marietta merged with Lockheed Corporation to form Lockheed Martin, a combine that also swallowed the aircraft business branch of General Dynamics. Northrop and Grumman also merged to form Northrop-Grumman. This trend has been driven by the imperatives of shrinking orders in a post Cold War world and the extremely high cost of operation in the modern aerospace industry. A similar process has been seen in Europe as well with British Aerospace swallowing up the earlier large number of British aircraft manufacturers such as Hawker, Folland, English Electric, etc. The European Aeronautic Defence and Space (EADS) company has included a large number of European aerospace companies, including even major players such as Airbus Industries, Aerospatiale, Matra, Deutsche Aerospace SA (DASA), etc.<sup>47</sup> These mergers have been forced by real world conditions of shrinking markets and increasing technological difficulties in pushing the frontiers of aerospace technology for future equipment in both the military and civil

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46. "US Government Policy and the Defense Aerospace Industry", RAND Report MR 1537, Chapter 1.

47. *Ibid.*

fields of operation. Even development programmes have now tended to adopt a multi-national character apart from a multi-corporate involvement, indicating that even the resources of advanced countries are proving inadequate for developing cutting edge aerospace products. Europe has the European Space Agency (ESA) as a combined effort of several West European countries, while EADS likewise combines resources in aerospace. The US adopted a multi-national structure for its F-35 "Lightning-II" LO fighter in part due to the need to secure adequate sales numbers and also to share costs and project risks. Europe's Eurofighter Typhoon also adopted a multi-national development and manufacturing structure, as had been done earlier for the European Tornado aircraft. The newly consolidated European firms, including Thales, which was earlier Thomson CSF, are now of a comparable scale as the earlier, always larger, US aerospace companies. Thus, the mergers give the European companies a feeling of parity with their consolidated US counterparts.

In the 1990s, the US and European governments supported and even encouraged consolidation of their aerospace companies to enable these to survive in the face of smaller and fewer orders, and shrinking budgets overall. However, of late, concerns have surfaced about the excessive concentration of the industry. Fears have been voiced about the possibility of smaller technological advances in a situation of less competition, higher costs and fewer bids for projects. The US authorities have put forth their fears that they may no longer benefit from the higher technology offerings at lower costs that are traditionally spurred on by a competitive contract seeking environment.<sup>48</sup> The US authorities blocked a proposed merger of Lockheed-Martin and Northrop-Grumman.<sup>49</sup> This indicates the possibility of these governments possibly encouraging the splitting of their mega firms into smaller entities at some time in the future.

It is clearly brought out in the American Institute of Aeronautics and Astronautics Information paper of the year 2012-13, titled "Strengthening the National Commitment to Aerospace Research and Development" that

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48. Ibid., p.6.

49. Ibid., p.7.

American technological progress in the aerospace domain has been spurred on by government funded and monitored R&D activities. These R&D activities have not only developed new technologies but pursued these new technologies till such time as these were mature enough to be commercialised by the larger aerospace industry comprising primarily private aerospace companies. Such government support for R&D is the bedrock on which the American aerospace industry has been built. The paper further brings out that shrinking government budgets for, and reduced government involvement in, cutting edge R&D could sound the death-knell of the US' aerospace leadership. That even the large private companies in aerospace such as Lockheed-Martin and Boeing are unlikely to be able to afford carrying out R&D on their own is a sobering dose of reality.

### **THE SOVIET / RUSSIAN AIRCRAFT INDUSTRY**

Interest in aviation theory in pre-Soviet Russia commenced in the later years of the 19th century. Several theoretical studies into the science of heavier than air flight were conducted by eminent Russian scientists. Russia at the time was the most industrially backward of the great European powers and was losing out on its share of the industrial goods market in Eurasia due to the backwardness of its manufacturing industry as compared with those of Britain, Germany, and France.<sup>50</sup> Russian scientists, most prominently Nikolai Kibalchich and Alexander Mozhaisky, contributed to the Russian research into the theory of heavier than air flight from the early 1880s<sup>51</sup>. As early as 1902-03, the Imperial Russian Army utilised tethered aerostats, organised into aerostat battalions, for ground observation and direction.

#### ***TsAGI***

In 1904, Nikolai Zhukovsky, often regarded as the father of Russian aviation, established an Aerodynamic Research Institute at Kuchino village

50. Z. Ubaidulloev, "The Russian-Soviet Legacies in Reshaping the National Territories in Central Asia: A Catastrophic Case of Tajikistan", *Journal of Eurasian Studies*, vol 6, issue 1, January 2015, pp. 79-87, URL: <http://www.sciencedirect.com/science/article/pii/S1879366514000104>. Accessed on July 9, 2015.

51. Scott W. Palmer, "Science and Technology(Russian Empire)", [http://encyclopedia.1914-1918-online.net/article/science\\_and\\_technology\\_russian\\_empire](http://encyclopedia.1914-1918-online.net/article/science_and_technology_russian_empire). Accessed on July 6, 2015.

near Moscow. This institute, established on December 1, 1918, was named as "Tsentralniy Aerogidrodinamicheskiiy Institut"(TsAGI), translated as the "Central Aerohydrodynamic Institute named in honour of Nikolai Zhukovsky" and is in existence even today. It was formed with the aim of carrying out research into various aspects of flight from a theoretical point of view, aimed at later practical application by the national aerospace industry, much the same charter that NACA (later NASA), TsAGI's American analogue, had when formed later in 1915.<sup>52</sup> TsAGI has also contributed towards the Soviet space programme through studies and developing shapes and structures for safe and reliable transit of spacecraft through the atmosphere as NASA did from 1958 onwards. TsAGI carried out theoretical as well as practical research, followed by prototype development and testing till proving and maturing of new concepts and technologies, prior to these being given to the specific Opytnoye Konstruktorskoye Buro (OKB), translated as "Experimental Design Bureau" for implementation on a wide scale.<sup>53</sup> The striking similarities in the aerodynamic design features of several Soviet era aircraft such as the MiG-29 and Sukhoi SU-27, which both feature highly blended wing body structures, with a lift providing fuselage design integrated with LERX, and extensive use of complex vortex generation and placement for extreme manoeuvrability, including extremely high angle of attack controllability, and chevron clipped tail fin tips, point towards new discoveries in aerodynamics at a central agency being shared equally with different design bureaus. Even earlier, the MiG-21 and Sukhoi (SU)-9 / SU-11 showed remarkable similarities in design, comprising slim, narrow and dense fuselages, with annular nose mounted air intakes coupled with a tailed delta wing configuration, the wings featuring boundary layer fences and ventral fins to supplement the dorsal tail fin. MiG-23 variants and the SU-24 also show remarkable similarities in design features. All these similarities in aircraft from different OKBs could be attributed to implementation of the TsAGI research findings at these OKBs.

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52. Tsagi.com, "About Us", <http://tsagi.com/institute/>. Accessed on July 6, 2015.

53. Ibid.

**While the bulk of the Imperial Russian Air Force comprised imported or licensed built aircraft, domestic Russian designers did display high skill in design and manufacture of aircraft.**

*Imperial Russian Military Air Arm and Aircraft Industry*

Impressed with the feats of early aviation such as the first trans-English channel flight by Louis Bleriot in July 1909, Tsar Nikolas II earmarked close to one million roubles for the formation of an air arm in the Russian military.<sup>54</sup> This was followed by a voluntary subscription campaign to raise funds for purchase of aircraft and engines. In 1910, Russia sent several officers to France to be trained as pilots and also bought several French and British aircraft to form an air arm of the military.<sup>55</sup> By mid-1914, Russia fielded the largest air arm of the military in Europe in terms of numbers, after France. However, being either direct imports, or foreign designs built under licence in Russia, the bulk of Russian aircraft were obsolete to the extent of their being barely useable in practical military operations.<sup>56</sup>

While the bulk of the Imperial Russian Air Force comprised imported or licensed built aircraft, domestic Russian designers did display high skill in design and manufacture of aircraft. Amongst the early Russian aircraft designers, Igor Sikorsky deserves special mention. In 1913, he had designed and built Russia's and the world's first multi-engine aircraft. Later the same year, he built a more practical four engined version named the "Ilya Muromets".<sup>57</sup> In 1913, designer Dmitry Grigorovich built several flying boats for the Imperial Navy.<sup>58</sup> By the end of World War I, 73 more Ilya Muromets were constructed, giving Russia, its and the world's first long range strategic strike air arm.<sup>59</sup> In 1916, Sikorsky designed his four-engined bomber called the "Alexander Nevsky". This aircraft was never put into

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54. Palmer, n.51.

55. Ibid.

56. Ibid.

57. Ibid.

58. Sovietbases. thecelotajs.com "Imperial Russian Air Force Service", <http://sovietbases.thecelotajs.com/The-Imperial-Russian-Air-Force.php>. Accessed on July 7, 2015.

59. Palmer, n.51.

production due to the Soviet revolution in Russia and Sikorsky's emigration to the US in 1919<sup>60</sup>.

In the 19th century, Russia was the least technologically advanced European power. Apart from implications for the country's economy, this industrial backwardness affected its ability to develop and sustain high technology armed forces. The materials, technology and techniques for the advances in most fields, including aviation, came from outside the country. Foreign businesses and businessmen promoted development of advanced technologies in Russia from an investment point of view. The development of more advanced industries gave the foreign promoters the profits they sought. The resultant gain was that Russia benefited in catching up to some extent with its more advanced Western neighbours in Europe. The dependence on outside suppliers for strategic materials posed problems. In the first decade of the 20th century, earlier Russian efforts to generate the human resources to enable domestic production of required raw and intermediate materials began to bear fruit.<sup>61</sup> The earlier Russian investment in centres of excellence in scientific education, including several polytechnics, carried out in the 19th century onwards, began to make available well educated personnel able to effectively operate high technology enterprises; the most obvious and visible result of which was initially the reduction in the numbers of expatriates working in advanced technology sectors of the Russian economy as Russian graduates of Russian centres of higher learning began to take over the expatriates' functions effectively.<sup>62</sup>

The pitfalls of dependence upon foreign sources for raw materials, intermediate goods and finished products was brought out severely during World War I. In this period, foreign supplies were severely disrupted by geography, with a hostile Germany situated between Russia and friendly France, and with Russian ports also facing a German blockade, thus,

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60. Ibid.

61. Ibid.

62. Ibid.

disrupting imports of essential commodities. The domestic Russian industry was not prepared 'to go it alone' and faced major problems in delivering the required equipment.<sup>63</sup> This experience forced Russia to develop its industrial sector on a war-footing; however, these efforts were hampered by the general lack of literacy in the population at large. Progress was made in isolated fields such as development of Sikorsky's "Ilya Muromets".<sup>64</sup> An effect of this experience was the shift of the focus of Russia's scientific community from pure theoretical research to trying to ground their work towards a practical world of real orientation.<sup>65</sup> Building in simplicity and ease of rapid construction into the equipment, especially military equipment, was also an offshoot of the problems faced by Russian industries during World War I. This basic philosophy carried forward into the Soviet era and beyond.

Much as in the US, as seen earlier in this paper, in the Soviet Union too aircraft design commenced with the efforts of a few talented designers. In addition to the problems associated with setting up new facilities for aircraft design and production in any region of the world, in the Soviet Union, aircraft designers also had the requirement of being seen as conforming to the codes of conduct and behaviour stipulated by the Communist Party apparatus. Membership of the Communist Party was a starting point for successful operation in the aviation field. The Soviets set up several OKBs centred on talented designers such as Pavel Sukhoi [Sukhoi (SU) OKB], Artyom Mikoyan [Mikoyan (MiG) OKB], Andrei N Tupolev [Tupolev (TU) OKB], Sergei Ilyushin [Ilyushin (Il) OKB], Oleg Antonov [Antonov (AN) OKB], and Alexander Yakolev [Yakolev (Yak) OKB]. Each OKB established and headed by these eminent designers in the past remains named after them even today.

### *The Soviet Aerospace Industry Model*

Nikolai Polikarpov was the Soviet Union's most successful designer of agile fighter aircraft during the 1920s and 1930s and into the early years of World War II. In the first few years of World War II, the Soviet Air Force

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63. Ibid.

64. Ibid.

65. Ibid.

was equipped predominantly, indeed, almost exclusively, with Polikarpov designed fighter aircraft. Nikolai Polikarpov is known to have followed a tight dictatorial style of functioning in running his design bureau. This style of functioning did not allow for much development of his subordinates. The famous MiG OKB was formed by two designers, A I Mikoyan and M I Guryevich, who were moved out of the Polikarpov design bureau in 1939. Key personnel of the bureau were moved out of the Polikarpov design bureau in 1939 subsequent to disagreements that Nikolai Polikarpov had with Stalin after a series of crashes of aircraft designed by Polikarpov, especially the I-180 and I-185 fighters.

A number of future chief designers of Soviet aircraft firms worked under the supervision of the famous French designer Paul Richard in his design firm, attached to TsAGI, in the USSR, in the 1930s and gained valuable experience: Lavochkin, Kamov, Korolev, Beriev, etc. were a few of these Soviet designers who gained through working under Paul Richard.<sup>66</sup>

Roberto Oros di Bartini left Italy and came to the USSR in 1923. He became a well-known aircraft designer and scientist. Bartini was imprisoned from 1938 till 1946 for political reasons. He worked in the SDB-29 with Tupolev and other designers. Bartini created over 60 projects of various aircraft, many of which were tested and saw limited production.<sup>67</sup>

The Soviet Union did not hesitate to utilise foreign experts working alongside Soviet scientists to help build up skill levels and competence in the Soviet scientific and engineering community.

After the death of Nikolai Polikarpov, in July 1944, his design bureau was closed down with its assets, including manpower, being transferred to other design bureaus such as the Lavochkin and Sukhoi design bureaus.<sup>68</sup> Hence, from the inclusion of the Polikarpov design bureau in the manufacturing establishment GAZ.84 in 1936 till 1944, this aircraft manufacturing organisation, which exists today at its location in Tashkent, Uzbekistan, as

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66. Vladimir Zhuravlev, "Russian Approach to Aircraft Design and Aeronautical Education", [http://www.dias.unina.it/EWADE2011/Presentations/Session\\_3/01\\_V\\_Zhuravlev\\_EWADE\\_2011.pdf](http://www.dias.unina.it/EWADE2011/Presentations/Session_3/01_V_Zhuravlev_EWADE_2011.pdf). Accessed on July 10, 2015.

67. Ibid.

68. J.Greenwood, et al., *Russian Aviation and Air Power in the Twentieth Century* (New York: Routledge. 2014).

the Tashkent Aircraft Production Organisation named after V.I. Chkalov (TAPOiCh), effectively carried out both design as well as manufacture of aircraft which was very rare in the Soviet aircraft industry; the fighters manufactured by TAPOiCh in this period were primarily those designed by Nikolai Polikarpov.

The Soviet system, save for a few exceptions such as at TAPOiCh, from 1936 to 1944, was very different. OKBs were the designated aircraft design agencies. These designed aircraft based upon their areas of broad specialisation, fighters, attack aircraft, transport, civil aircraft, or helicopters.

The Soviets are not known to have carried out a 'fly-off' for selection between different competing designs for one requirement as the US did in the 1970s and 1980s. However, there is a coincidental development of similar aircraft by different design bureaus such as the MiG-29 and SU-27 around the same time. Both aircraft saw induction and series production as, despite their similar looks, these addressed the short range (tactical) and long range (strategic) segments of the Soviet Air Force need for Generation 4 aircraft.

The production of the designs of OKBs was not done by the concerned designing OKB but by separate aircraft production facilities that were often located at large distances from the OKBs. The OKBs, for the most part, were located in Moscow or its suburbs, an exception being the Antonov OKB which was located in the outskirts of Kiev city in the Autonomous Soviet Socialist Republic of Ukraine. The production agencies were located in various different parts of the Soviet Union; often the location of factories being dictated by wider regional development and other political aims and not based upon economies of scale or reasons of competitive advantage enjoyed by some geographical locations over others. Nor was there a system of a specific production factory being associated permanently with a specific OKB. Designs were allocated to specific factories by the Soviet Union's central bureaucracy with no consideration for market forces and / or technical issues. Generation of employment and or work to keep plants in operation and the meeting of required production volumes appear to have been the deciding factors in such assignments of production. There were

cases of a single factory in the USSR running two or more assembly lines, one for a fighter and the other for a transport aircraft or even a helicopter under a single roof.<sup>69</sup>

### *MiG OKB*

The Artyom Mikoyan and Mikhail Guryevich team commenced independent design work in 1939 initially within the Polikarpov OKB<sup>70</sup> as a special cell and later, in 1942, was established at Zavod (the Russian word for factory) #155 as an independent MiG OKB led by Artyom Mikoyan, with Guryevich as his second in command.<sup>71</sup> The MiG OKB started designing aircraft with their MiG-1, upgraded (to overcome problems in the original design) later to MiG-3 standard.<sup>72</sup> It designed the USSR's first jet fighter, the MiG-9, which utilised captured Nazi era Bayerische Motoren Werke (BMW) jet engine technology, and made Soviet fighters a household name across the world with the MiG-15, MiG-21, MiG-25 and MiG-29 designs.<sup>73</sup> The MiG OKB was one of the Soviet aerospace industry's great success stories with its achievements spread consistently over a period of more than 60 years.

In the Soviet period, market forces and considerations were completely absent from the industrial system. The Soviet philosophy was akin to "if a thing is required, it will somehow be made available, with no extraneous considerations to the need coming in the way". This, in a larger context, meant that unlike in the West, cost was not a consideration in development of aerospace equipment. For national defence needs, cost was never a consideration. The Soviets appear not to have even kept track of the cost of developing and producing military and aerospace equipment in even the most rudimentary way. This freed the Soviet aerospace industry from the tyranny of cost control requirements. The ill-effect of this philosophy was that excessive amounts of national resources could be sucked into several

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69. Zhuravlev, n.66.

70. Russiapedia.rt, "Prominent Russians: Artyom Mikoyan", <http://russiapedaia.rt.com/prominent-russians/science-and-technology/artiom-mikoyan/>. Accessed on July 8, 2015.

71. Ibid.

72. The MiG-3 was essentially an improved MiG-1 which improved stability and other performance characteristics over the original aircraft.

73. Palmer, n.51.

**A consequence of the state control of all industry in the Soviet Union was the inability of individual OKBs or production agencies to interact with customers. All Soviet arms and aerospace exports were dealt with through central state authorities. The prices fixed had much more to do with politics than actual production costs.**

projects, with negative implications on the economy of the country. Some Western and Russian experts and analysts attribute the dismantling of the Soviet Union by President Gorbachev to the economic stress caused to the Soviet Union by its attempts to counter the US' high technology "Strategic Defence Initiative" or "Star Wars" initiative, aimed at global aerospace domination, which was commenced in the early 1980s in the tenure of President Reagan.<sup>74</sup>

A consequence of the state control of all industry in the Soviet Union was the inability of individual OKBs or production agencies to interact with customers. All Soviet arms and aerospace exports were dealt with through central state authorities. The prices fixed had much more to do with politics than actual production costs. Aerospace exports were usually utilised for furthering the Soviet Union's wider political aims.<sup>75</sup> In post Soviet Russia too, despite the initial move towards privatisation of the aerospace industry, the trend has of late been to consolidate the aerospace industry, in view of its national importance, under state control, making one umbrella state agency the only point of contact between foreign parties and the Russian aerospace industry.<sup>76</sup>

### *Post Soviet Russian Aerospace Industry*

The Soviet Union had several aircraft design bureaus such as the MiG OKB, now reorganised as the Russian Aircraft Corporation MiG (RAC MiG);

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74. Rt.com, "'Star Wars Destroyed Soviet Union' – Russian Space Chief", <http://www.rt.com/politics/russian-chief-star-wars-762/>. Accessed on July 8, 2015.

75. Introductory remarks by Mr Ajai Malhotra, former ambassador to the USSR, who was the chair for the seminar on "India-Russia Cooperation in Defence" and discussions and presentations during the seminar, on February 25, 2015, at the Seminar Room of Centre for Air Power Studies (CAPS), New Delhi.

76. Ibid.

Sukhoi OKB, now called the Sukhoi Aircraft Holding Company / Joint Stock Company (JSC) all the stock of which is held by the Russian United Aircraft Corporation(JSC) or (UAC); Ilyushin OKB, which today is known as the Ilyushin Aircraft Complex and forms part of the UAC; Antonov OKB, which is today called the Antonov Company and lies in present day Ukraine, outside the Russian aircraft industry, though with strong links to it, with the company headquarters outside Kiev city; Tupolev OKB, which today is called the Joint Stock Company Tupolev and is also part of the United Aircraft Corporation; and the Yak Aircraft Corporation which was earlier the Yak OKB and which is also today part of the UAC, to name a few of the more prominent ones since the end of World War II. A few of the more prominent aircraft building plants that lie within the Russian Federation even after dismemberment of the USSR are the Komsomolsk-on-Amur Aircraft Production Association (KnAAPO), Aviastar SP in Ulyanovsk, Kazan Aircraft Production Association (KAPO) in Kazan, and Irkutsk Aviation Plant, located at Irkutsk.<sup>77</sup> These aircraft manufacturing plants that lie within the Russian Federation are also now part of the UAC. The decision of where a design is to be manufactured is now done on lines closer to a commercial market driven process involving the designer and manufacturer, also unlike the earlier Soviet era bureaucratic decision process by the concerned ministry of the Soviet government. A severe resource crunch faced by Russia in the decade immediately following the dismantling of the USSR meant that new R&D projects in aerospace were not initiated till President Putin came to power and made the resurgence of Russia's aerospace industry a national priority.

**The decision of where a design is to be manufactured is now done on lines closer to a commercial market driven process involving the designer and manufacturer, also unlike the earlier Soviet era bureaucratic decision process by the concerned ministry of the Soviet government.**

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77. K.Hull, "In Depth Look: Aircraft Production in the Former Soviet Union", <http://www.airlinereporter.com/2014/03/aircraft-production-in-the-former-soviet-union/> Accessed on July 11, 2015.

## **ANALYSIS OF THE US AND SOVIET AEROSPACE INDUSTRY MODELS**

The US is a capitalist country with an emphasis on free enterprise and it places a premium on individuality and has a highly competitive 'winner takes all' culture. Imperial Russia was a feudal society characterised by a wealthy landed elite that lorded over an illiterate and oppressed peasant class. The Soviet Union, through the Bolshevik Revolution, ushered in a Communist system that placed priority on the greater good over individual rights and put in place a rigid and regimented society. Socialist ideals replaced capitalist ideas and resources were to be distributed amongst the people based on need more than anything else. The two systems of Communism and capitalism could not be more different in their fundamentals and concepts. In such a situation, it was only natural that the paths followed by the aerospace industries in these two countries would be very different. There are, as we have seen in the preceding paragraphs, several differences in the approach followed towards putting in place an effective aerospace industry in the US and the Soviet Union. While these were only to be expected, the surprising part was the similarity in the way a few things were done in the two countries, especially as regards utilisation of state resources for the benefit of ostensibly a relatively small part of the population. An analysis of the aerospace industry in the US and USSR is given below.

### *Points of Interest from Analysis of US and Soviet / Russian Aerospace Industries*

- In both the US and Imperial Russia, the genesis of the aircraft industry owes a lot to the interest taken by a few enthusiasts who took it upon themselves to develop basic theory and translate it into actual aircraft. In Russia, a central research institute was started by an academic who was an aviation enthusiast, while aircraft were built initially under licence, with a few Russian designers making their mark. In the US, the profit motive combined with enthusiasm for aviation for several individuals who started aircraft manufacturing companies. Both the Russians

and Americans realised the importance of an excellent scientific and engineering education to sustain the aircraft industry and took active measures to put this education system in place.

- In the US, barriers to entry were mostly those of a market economy with high economic wherewithal required to start a new enterprise. The US gained from its interaction with British and French designers and examination of European aircraft. The Soviets did not hesitate to utilise foreign designers working in Soviet research, design and development facilities alongside Soviet engineers and scientists to help the domestic scientific community assimilate the knowledge and skills of the foreign experts.
- Both the US and USSR systematically pillaged through the aerospace research carried out by the defeated Nazi Germany in order to leapfrog ahead in aerospace technology.
- In a situation of state ownership of all resources, it is not difficult to accept that TsAGI would carry our fundamental research, develop and prove new concepts and then pass these on to aircraft design bureaus for implementation as a part of the same monolithic state owned industry. However, surprisingly even capitalist America did the same with the NACA, later, NASA. Even America accepted that private industry, even an industry with high profit margins, could not carry out fundamental and applied research without state support and funding.
- The US aerospace industry relied upon exports as a means of maintaining financial viability in its market economy system. The USSR did not even track the cost of developing and building equipment and so had no concept of market prices for its products.
- Russia, and later the USSR, showed that a dedicated education and R&D effort with full state support can lead to achievement of global excellence.
- Aerospace R&D requires state support in terms of state involvement in the R&D process. R&D in aerospace is too expensive to be borne alone by even large and profitable private companies.
- Dependence upon foreign supplies of defence equipment can be very problematic in times of need and should be avoided.

- A country making an attempt to catch up with the global state-of-the-art in aerospace could do so more effectively through intelligent utilisation of collaboration with more advanced countries.

## CONCLUSION

Since its advent, aerospace has come to occupy a prime position in the defence and security calculus of nations. A robust domestic aerospace industry has come to be seen as a guarantor of security as well as a significant contributor to the nation's economy. These facts make the study of the US and Russian / Soviet aerospace industry very educative. The process followed by the USSR and the US in developing their aerospace industries brings out the political and economic system neutrality of end user and governing system support for the development of a cutting edge technology-based industry. Cutting edge R&D is required for sustaining effective operation of an aerospace industry. Even very large multinational firms such as Boeing and Lockheed-Martin are unable to afford the resource outlays required for this purpose. Thus, government support of R&D, even with private companies involved, is essential. The study of the aerospace industries in the US and USSR throws up several more interesting points.

# HUMAN SYSTEMS APPROACH TO A MORE EFFECTIVE APPLICATION OF AIR POWER

M MISRA

Since the advent of the heavier than air flight in 1903, theorists have posited numerous schemes to best exploit the inherent ability of aircraft to rise above the fray of the battlefield and go straight to the heart of an enemy nation. The seeds sown by these theories have steadily evolved throughout the 20th century. Along the way, the theories have been fashioned by the lessons of war, remarkable advances in technology, and the visionary concepts of a few, select airmen. Two modern-day theorists, Col John Boyd and Col John Warden, have significantly contributed to this evolutionary process. While Boyd does not offer an air power theory *per se*, his thoughts on conflict have significant implications for the employment of air power at all levels of psychological war. In contrast, Warden has developed air power theory, but primarily focusses on the strategic application of the air weapon.

The question for air power theorists must be, "Where should air power be focussed in order to contribute to effects?" This paper argues that the existing disparate air power theories are part of a continuum that can be integrated using a **human systems model**<sup>1</sup> to provide a range of options for influencing an adversary's means and will. The paper elucidates that the human systems model offers an explicitly holistic view of the adversary as a

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1. Sqn Ldr A H Killey, RAF, "Air Power Compendium Beyond Warden's Rings? A Human Systems Approach to the More Effective Application of Air Power".

**The context is the key question for air power theorists, “Where should air power be focussed in order to contribute to joint effects?” Seemingly competing theories have emerged that variously advocate focussing the role of air power to influence the adversary’s physical means or moral will.**

system, and provides a conceptual framework for understanding the cascade of direct and indirect physical and psychological effects. It postulates that air power is most effective when used to influence an adversary’s will, rather than his means, but its use must always be tailored to the properties of the adversary and the political objectives.

Air power transformed the conduct of war in the 20th century<sup>2</sup>; the end of the Cold War, the phenomenon of globalisation and trans-national terror-based organisations aka Islamic State in Syria (ISIS) are transforming global security in the 21<sup>st</sup> century.

When influencing an adversary’s will, should air power aim to paralyse his ability to decide what to do, or to change the gains the adversary hopes to make from choosing a particular course of action?

– Clausewitz

The context is the key question for air power theorists, “Where should air power be focussed in order to contribute to joint effects?” Seemingly competing theories have emerged that variously advocate focussing the role of air power to influence the adversary’s physical means or moral will. Within these arguments run sub-currents of strategic thought: should air power concentrate on influencing the means at the strategic or operational level? When influencing an adversary’s will, should air power aim to paralyse his ability to decide what to do, or to change the gains the adversary hopes to make from choosing a particular course of action? It must be brought out here that these are two striking examples in the same air force which has used the same strategy for two engagements, separated by time. First, refer to Gulf War 1 where strategic paralysis was achieved in four days using Warden’s model.

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2. David S Fadok (USAF), Directorate of Conceptual Studies Air HQ VB Study Material.

However, the same was not applicable to the ISIS, because a higher bombing level caused an increase in the motivation levels to resist.

The purpose of this paper is to argue that these theoretical perspectives are part of a continuum that can be integrated to provide a range of options for influencing an adversary to comply with one's will. The decision as to which portion of the continuum is to be used, must be based on an understanding of the adversary, the objectives of both sides, and

on what must happen to the adversary to achieve political objectives.<sup>3</sup> First, each theoretical approach is briefly reviewed, highlighting its strengths and weaknesses, and employment in recent military operations.

Boyd's thoughts on strategic paralysis are process oriented and aim for psychological incapacitation. He speaks of folding an opponent back upon itself by operating inside the Observe, Orient, Decide, Act (OODA) cycle. Boyd's aim is to cause psychological incapacitation by a decision dilemma. Warden's theory of strategic attack is a form-oriented attack and aims at physical paralysis. It advocates parallel inside-out attacks against the enemy's five strategic rings. Next, a model based upon the characteristics of human systems is proposed as an integrating framework for the different strands.

**Warden's theory of strategic attack is a form-oriented attack and aims at physical paralysis. It advocates parallel inside-out attacks against the enemy's five strategic rings.**

## **DESCRIPTION OF HUMAN SYSTEMS: THE HUMAN SYSTEMS OF THEORY**

Human organisations adopt a course of action as a result of **their means** and **will** to do so. Means and will are the collective outputs of the systems that make up a human organisation, be it a nation-state, a trans-national corporation, or a terrorist group. A system is a collection of elements connected together to achieve a common purpose.<sup>4</sup> Although, there are many methods to classify systems, this paper adopts the definition used

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3. *Air Force Manual 1-1: Basic Aerospace Doctrine of the United States Air Force*, vol II (Washington DC: Department of the Air Force).

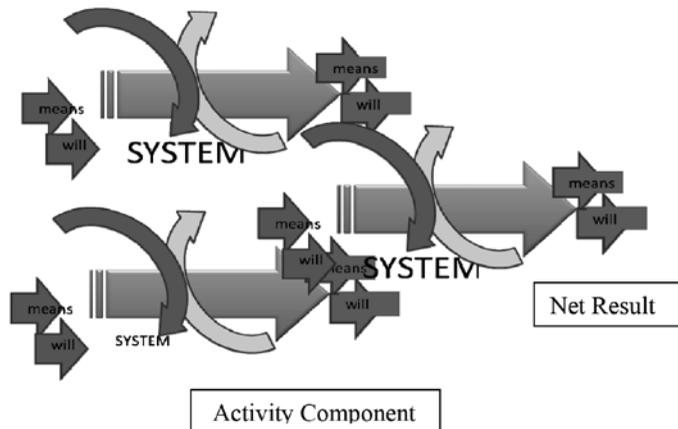
4. Cdr Lawrence N Ash, *Fighting for Network-Centric Warfare*, Proceedings (August 2000), pp. 74-76; Thomas PM Barnett, *The Seven Deadly Sins of Network-Centric Warfare*, Proceedings (January 1999), pp. 36-39.

by Warden’s five-rings model as it permits a common frame of reference for analysis. Human systems – systems in which humans form an integral element – possess a high level of internal linkage, the ability to self-regulate, adapt and respond unpredictably. All human systems are made up of two components: an activity component that produces goods, services, organisations; and information, overlain by a cognitive component that decides how the activity component behaves (see Fig 2 below).

Fig 1



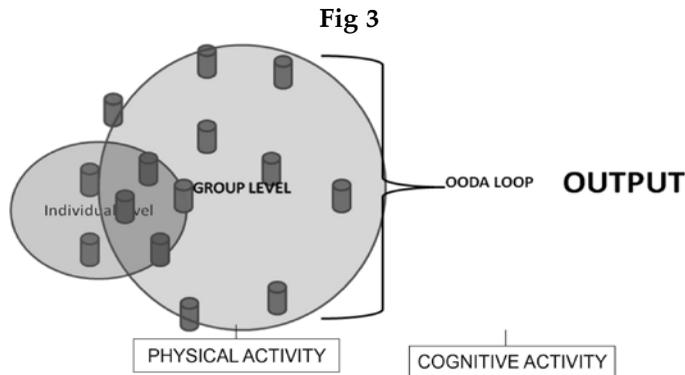
Fig 2



**Activity Component**

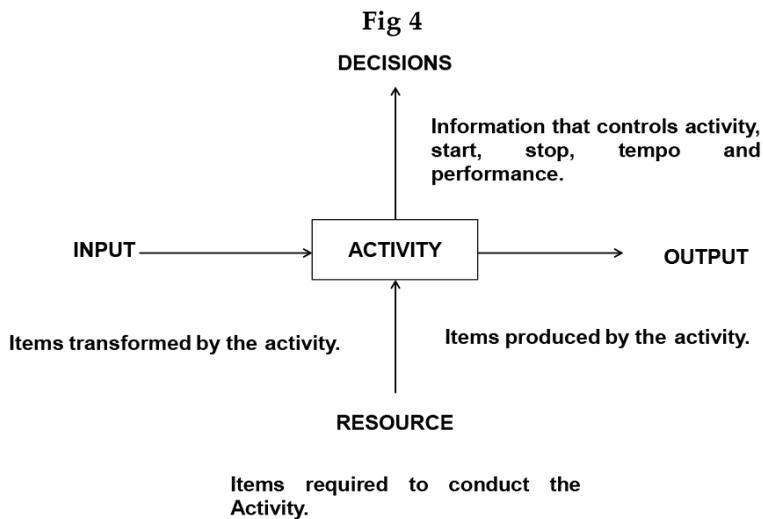
This is made up of collections of individuals and groups, connected by interpersonal relationships at both individual and group levels. These individuals and groups make decisions on the basis of what they observe about the output of activities, analyse what they perceive, make judgments about the situation, decide how to respond or act, and then control the activities

to be performed in a required manner. The processes used to observe, perceive, judge and decide are described in Boyd's OODA loop model. It is a combination of the activity component producing outputs and a cognitive component making decisions that gives human systems the properties of self-regulation, adaptation and unpredictable responsiveness.



***The Cognitive Component***

The activities in a human system are controlled and coordinated by the cognitive component.

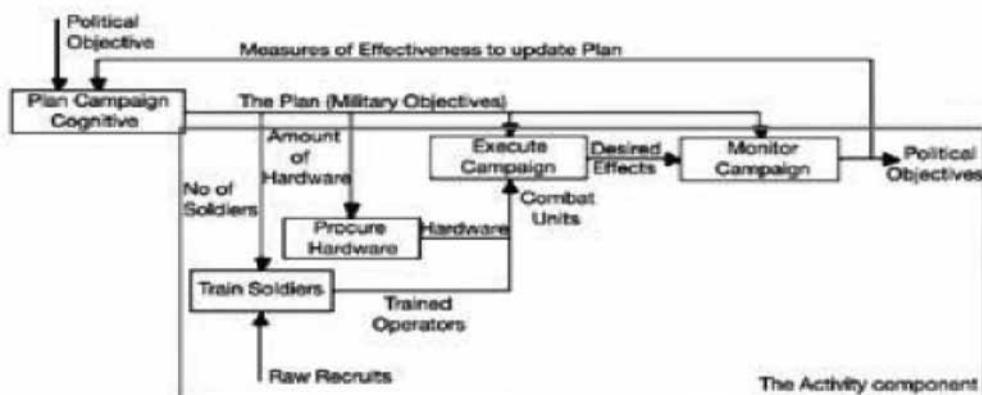


**ACTIVITY, INPUTS, OUTPUTS, RESOURCES AND DECISIONS**

*The Activity Component*

The activity component of a human system <sup>5</sup>is made up of a collection of linked physical activities that transform inputs into desired outputs, in accordance with decisions, using resources (see Fig 3). One activity's outputs are another activity's inputs or resources<sup>6</sup>. Inputs can be tangible items such as raw materials for a manufacturing process, or intangibles such as information input into a computer system. Outputs can be tangible, such as manufactured products or services, or intangible items such as concepts or information. Resources are required for the activity to take place, but are not transformed into the output; for example, the people required to carry out procedures; production machinery, infrastructure, i.e. factories and offices in which to conduct work; power, heating and lighting. The information controlling when activities start and stop, the rate at which they transform inputs into outputs, the use of resources, the standards to work to, and the targets to reach, are all derived from decisions made by the cognitive component.

**Fig 5: The Elements and Links in the Activity Component**

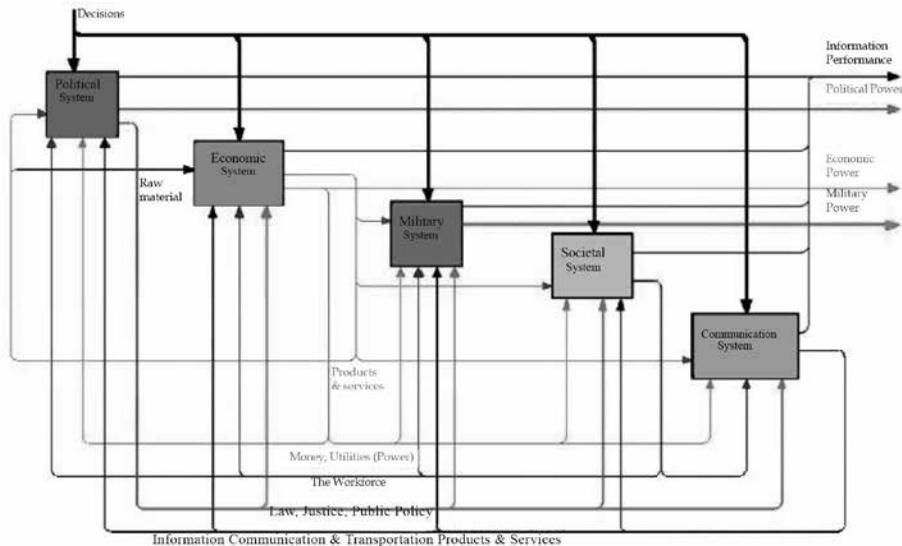


5. That is to say that, working together, the elements produce something greater than if the activities worked in isolation. See Wilson (1990), pp.24, 40, and Warden (1995).  
 6. Ibid.

Activities provide outputs that are used by other activities, whether as inputs or resources, and these link activities together and make them dependant upon each other. For example, an activity that outputs petroleum products is producing an input for a military system, and an activity that outputs electricity is providing a resource for all activities that require electrical power. This dependency of activities upon outputs is as important as the transformation carried out by the activity itself. It is the combination of individual outputs that defines the system's collective output, and human systems need a minimum degree of connectivity for the output to be produced. For example, national military power is the sum of all the activities that design, manufacture, transport and support combat equipment, and those activities that recruit, train and administer the personnel. As more and more activities stop delivering their outputs, the system reaches a point at which it cannot deliver military power. Human organisation systems are not only dependent upon the connectivity of their internal activities; they are also dependent upon outputs from the internal activities of the other systems, producing a network of interdependence (see Fig 6). In this respect, the human systems model differs substantially from Warden's hierarchical model. Like Warden's model, each system can be continuously broken down in more and more detail to provide greater definition of the connectivity between activities. The relative dependence between each system is contingent on many factors, including the size, purpose and culture of the organisation.

**National military power is the sum of all the activities that design, manufacture, transport and support combat equipment, and those activities that recruit, train and administer the personnel. As more and more activities stop delivering their outputs, the system reaches a point at which it cannot deliver military power.**

Fig 6



The interdependence of systems in the human system, and sub-systems will lead to a detailed understanding of how the systems deliver outputs, and will identify which activities are critical for the production of a given output.

**CENTRES OF GRAVITY (CofG)**

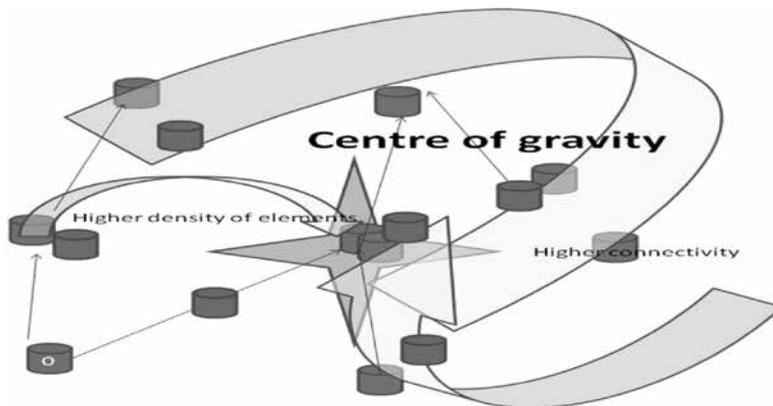
Within each system, there will be a region where the number of elements and density of links, both between the elements within the system and between the cognitive and activity components, is relatively high. This is the region of the system that makes the most significant contribution to the system’s collective output. An adversary’s Centre of Gravity (CofG) is a region where sufficient connectivity exists among the elements to enable the system to deliver an output that is critical to providing the adversary with the means and will to undertake a course of action, at a specific time (a critical capability).<sup>7</sup>

These critical outputs are not necessarily the adversary’s greatest strength or weakness and unless the adversary has sufficient connectivity, he may not necessarily have a CofG. As each system may have a region of

7. For a detailed analysis of critical capabilities, requirements and vulnerabilities, see J Strange, “Centers of Gravity and Critical Vulnerabilities,” *Perspective on War-Fighting*, no. 4 (US Marine War College).

high connectivity, the adversary may have more than one CofG, as is the case with Warden's 5-ring model. Where sufficient connectivity does exist, the human systems model can be used to identify the elements and links that form the CofG. This concept of a CofG mirrors Clausewitz's contention that a CofG is the "hub of all movement and power".

Fig 7



**System Self-Regulation and Adaptation:** Human systems are constantly subjected to influence from their external environment and they possess the ability to respond to it by making decisions that modify the outputs that activities deliver. The rate at which activities produce outputs depends not only on decisions but also on the availability of inputs and resources. Consequently, changes in an activity's performance may propagate along the output links and affect the performance of activities that use that output. The cognitive component coordinates all the changes necessary to respond, or adapt, to environmental influences. Performance information from activities is used by the cognitive component to decide how to adjust activities in the system. These adjustments may work to minimise the impacts of external influences, or to adapt the system to its new environment if this leads to survival or a more effective method of achieving the common goal. For example, military systems are able to react to the consumption of assets by resupplying themselves in order to maintain a relatively constant level of combat potential. Human systems have too many elements and links to

exist in a steady state of activity and are inherently dynamically unstable, as influences and decisions work their way through the output links in the system. The ability to cope with, or adapt to, the environment means that the same influence applied to the same point of the system at a different time may result in a very different outcome because the system has adapted. This means that the effects of external influences can be time-sensitive.<sup>8</sup>

However, a human system's ability to cope with, or adapt to, the external environment is constrained in two ways. Firstly, the range of output that an activity can deliver is limited by the quantity of input or resource available. Secondly, the changes brought about by an external influence can exceed the cognitive component's ability to perceive, recognise, control and coordinate changes to, performance across many activities. The role of perception and judgment in the cognitive domain and the inherent dynamic instability of human systems mean that they often display non-linear responses to external influences: seemingly powerful influences may have a limited effect whilst small ones may have a disproportionately large effect. Furthermore, external influence may have little effect until some 'critical mass' is reached or have no effect unless some other condition is present. For example, a fielded force in combat can continue to fight whilst taking casualties, until a critical level of degradation is reached, at which point the force collapses.

### **APPLICATION OF HUMAN SYSTEMS TO AIR WARFARE**

This is the most dynamic form of warfare in terms of time, changes to the ground situation and the effect of a single weapon delivered accurately. The ability of an organisation to behave in a certain manner is a product of its physical means and moral will to act. Means are the collective output of the activity component and will is the collective output of the cognitive component. Shaping an organisation's behaviour requires exerting influence on its means, will, or both. The application of the human systems model to warfare identifies three strategic approaches for exerting influence on an adversary: destruction of the system's elements, disruption of the

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8. Andrew Ilachinski, *Land Warfare and Complexity*, Part II. Assessment of the Applicability of Non-Linear Dynamic and Complex Systems Theory to the Study of Land Warfare (Alexandria VA, Centre for Naval Analysis, July 1996), pp.139-140.

system's connectivity, and exploitation of the system's control mechanism. These three strategic approaches are assessed in the light of three recent operations, Desert Storm, Deliberate Force and Allied Force.

### **SYSTEM DESTRUCTION STRATEGIES**

System destruction strategies aim to destroy the elements of an adversary's system with the objective of denying the adversary the means to pursue a course of action. Moral will is an abstract concept and cannot be targeted directly by physical means. Consequently, the focus of system destruction strategies is on the system's physical elements, particularly the fielded forces, although all systems have physical elements that, theoretically, could be destroyed.

In Operation Desert Storm, the fielded forces provided Iraq with the means to occupy Kuwait. Up to 12,000 Iraqi troops were killed, the combat effectiveness of many units was reduced by 100 percent and the Iraqi Army in Kuwait collapsed. System destruction strategies aim to destroy the elements of an adversary's system with the objective of denying the adversary the means to pursue a course of action. Moral will is an abstract concept and cannot be targeted directly by physical means. Although the coalition achieved air superiority within 48 hours of the start of the operation, it still sought the physical destruction of the Iraqi Air Force. Despite destroying runways, taxiways and hardened aircraft shelters, nearly 45 per cent of Iraq's aircraft emerged from the war unscathed. However, it took 23,430 sorties, approximately two-thirds of the coalition's air power, to achieve this defeat, and more Iraqi soldiers deserted than were killed. The key political objectives of the complete destruction of the Republican Guard and Iraq's nuclear, biological, and chemical weapons programmes were not achieved despite the coalition's overwhelming military power. The Republican Guard suffered about 24 percent attrition, but remained sufficiently capable to withdraw from Iraq and, subsequently, suppress the Kurdish and Shiite rebellions. Only 25 percent of Iraq's nuclear weapon programme sites were attacked and the efforts to destroy Scud missile systems and chemical and

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biological weapons were disappointing.<sup>9</sup>

One of the strategies implemented in Desert Storm was the destruction of a small number of political targets in the hope of decapitating the regime, leading to regime change or decision-making paralysis. However, political targets proved difficult to locate and strike effectively. Decapitation may have been unachievable and undesirable as there was no evidence that the death of Saddam Hussein would have resulted in the reins of power being taken up by someone with the ability or desire to unconditionally withdraw the Iraqi

Army from Kuwait.<sup>10</sup> Saddam Hussein's regime was not decapitated and remained sufficiently in command of its forces in Kuwait to coordinate the orderly withdrawal of the Republican Guard from Kuwait.<sup>11</sup> Targeting the adversary's systems for wholesale destruction is a strategy that has not been employed since Operation Rolling Thunder in Vietnam. The destruction of organic essentials and infrastructure to debilitate the fielded forces was a central tenet of the strategic air offensives against Germany and Japan during World War II. However, as this demonstrated, these systems are difficult to destroy entirely, requiring precision bombing, and having considerable capacity to absorb punishment, and regenerating or finding alternative sources for inputs and resources and rerouting outputs.

The destruction of the adversary's population, as genocide or ethnic cleansing, involves mass murder, systematic terrorisation and enforced relocation of an ethnic group, and has been a feature of recent intra-state conflicts. Up to one million Muslims were expelled from their homes in

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9. Despite claims that Iraq's nuclear, biological, chemical weapons programmes had been destroyed by six weeks of bombing, the United Nations team soon discovered that more than 100 Scud missiles had survived, as had missile production equipment, and at least 19 mobile launchers, and components from new, two-stage missiles. In addition, 70 tons of nerve agent and 400 tons of mustard gas also escaped destruction. Atkinson (1993), p.496.

10. Watts et al, (1993), p.27.

11. Eduard Mark, *Aerial Interdiction In Three Wars* (Washington DC, USA: Centre for Air Force History, 1994), p.224; Pollack (1996), pp.548-555.

Serbian-occupied areas in Bosnia between 1992 and 1994. In Kosovo, Serbian security forces killed up to 10,000 and created an estimated quarter of a million refugees. However, as the perpetrators of such crimes against humanity have discovered, not it is only extremely difficult and morally reprehensible to destroy a population entirely, it is illegal under international law.

Despite the perceived relative ease of finding targets for physical destruction as compared to targeting an adversary's will, the level of force and effort required means that physical destruction of a system may not be the cheapest, quickest, or even legal method of achieving political ends. Decapitation may remove the only means of establishing a dialogue with the adversary. Attempts to destroy command and control have not been effective and the destruction of lines of communication, particularly bridges, can impede the movement and resupply of friendly forces. The destruction of organic essential systems and infrastructure has some significant disadvantages for peace in the state afterwards. For the resulting organisation to rebuild itself post conflict, those elements of the system that have been destroyed may need to be rebuilt rapidly. In addition, the mass casualties and extensive collateral damage that such economic warfare produces is becoming increasingly politically unacceptable to modern Western liberal democracies.

The horrific loss of life and cost in national treasure that fighting entails, illustrated by two World Wars, has always stimulated the search for more effective ways of influencing the adversary's means and will, by disrupting the output from these systems rather than attempting a systems destruction by hard fighting.<sup>12</sup>

**One of the strategies implemented in Desert Storm was the destruction of a small number of political targets in the hope of decapitating the regime, leading to regime change or decision-making paralysis. However, political targets proved difficult to locate and strike effectively.**

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12. Basil H., Liddell Hart, *Strategy* (London: Faber & Faber Ltd, reprint, New York: Penguin Books, 1991), p.21 (page references are to reprint edition).

## SYSTEM DISRUPTION STRATEGIES

The connectivity between and within human systems is a vulnerability as well as the source of its collective outputs. An adversary's fielded forces are dependant upon outputs from the leadership, organic essentials, and infrastructure and population systems. System disruption strategies target a system's connectivity with the intention of reducing it below the level of minimum essential connectivity, not its destruction. At this point, the functioning of the system is degraded to such an extent it is no longer able to deliver its outputs and the adversary will be denied the use of his fielded forces. In all the case study operations, the disruption of the connectivity in the military Command and Control (C2) activities aimed to deny the military system any enhanced combat effectiveness through integration. This is best illustrated by the efforts to deny the air defence output provided by an Integrated Air Defence System (IADS) in order to gain access to the rest of the military and other systems. In all cases, the IADS was disrupted by physical strikes on communication nodes, disruption of electrical power, and destruction of the early warning radar sites, surface-to-air missiles guidance radars, and missile launchers, and sector operations centres.

In all cases, the IADS was driven into systemic failure in the first 48 hours, successfully forcing the adversary's air defences to operate autonomously, if at all, and permitting access to all the adversary's systems.<sup>13</sup>

In all three case studies, one of the strategies chosen was to target the infrastructure system to disrupt (interdict) resupply to the fielded forces. Military depots, storage facilities, supply infrastructure and transportation systems were attacked. During Desert Storm, the coalition substantially degraded supply capacities. In Deliberate Force, this disruption strategy so successfully denied the Bosnian Serbs their essential war stocks that they seized UN Protection Force personnel as hostages and chained them to storage buildings in an effort to halt the bombing. However, "anybody that does a campaign against transportation systems [had] better beware! It looks deceptively easy. It is a tough nut to crack." The Iraqis proved ingenious at using pontoon bridges, ferries, causeways, alternate routes, and underwater

13. In each operation, low level air operations were still prevented by the proliferation of hand-held surface-to-air missiles and anti-aircraft artillery.

bridges to keep sufficient supplies flowing into the theatre. After achieving their initial objectives in Kuwait, they adopted a static posture, using stockpiled ammunition and diesel fuel sufficient for weeks or even months of combat. There were some frontline units that experienced extreme shortages of food and water but overall, the Iraqi Army was not defeated due to lack of supplies.

During Operations Desert Storm and Allied Force, oil refining, distribution and storage facilities, and military production facilities were all struck by air power. The objective in targeting selected organic essentials activities was to cripple specific outputs, military material and refined petroleum products.

During Desert Storm, the coalition reduced oil refining capability by 93 percent and 20 percent of petroleum products held at refineries and major depots were destroyed. During Operation Allied Force, 50 percent of Serbia's war industries were largely destroyed. Oil refineries were targeted and petroleum reserves dwindled, dual-use vehicle manufacturing plants and chemical industry plants were struck to deny the Serbian military resupply and reinforcements. The effectiveness of disrupting organic essentials is dependent upon the resupply requirements of the fielded forces; for example, the Iraqi Army had limited resupply requirements, so disruption of organic essentials did not affect the fielded forces in any significant manner.

An additional purpose of targeting electricity generation plants during Operations Desert Storm and Allied Force was to disrupt power to the communication and information system that linked decision-makers and military commanders. The Iraqi electrical supply was reduced by 88 percent. As with the attempt to destroy the C2 system in Desert Storm, the attempt to disrupt C2 was not effective in Allied Force, as Milosevic had sufficient control to withdraw the Serb forces from Kosovo, promptly and in good order

Disruption strategies can be differentiated by the choice of system to be influenced, and the depth to which the system is disrupted. Disruption can be achieved without applying the same level of force as to system destruction, and potentially exposes fewer personnel to risk. Its effectiveness in denying the adversary his means can be decisive, as the disruption of IADS in all three case studies shows. However, the effectiveness of the disruption of C2

**During Operations Desert Storm and Allied Force, oil refining, distribution and storage facilities, and military production facilities were all struck by air power. The objective in targeting selected organic essentials activities was to cripple specific outputs, military material and refined petroleum products.**

and resupply to the fielded forces is entirely contingent upon the character, posture and intent of the fielded forces. As such, the use of a system disruption strategy needs to be matched to the military context.

System disruption strategies have been described only in terms of achieving purely Clausewitzian physical effects. However, "Physical force does not win a war, mental force does not win a war. What does win a war is the highest combination of these forces acting as one force". Every activity in a human system is controlled by a cognitive component and all physical effects will inevitably have a psychological effect on the adversary's cognitive component.

Therefore, system disruption strategies can initiate a cascade of physical effects that have psychological effects on the adversary's decision-making.

System exploitation strategies seek to exploit the linkage between the activity and cognitive components in one of two ways; either by influencing the cost-benefit calculus of the decision-making process so that the adversary chooses an acceptable course of action, or manipulating the system's limited self-control capability.

## **SYSTEM EXPLOITATION STRATEGIES COST/BENEFIT MANIPULATION**

Within the cognitive component, decisions are based on the decision-maker's perception and judgment of the costs and benefits of a course of action. A rational actor will adopt a course of action that maximises the benefits and minimises the costs.<sup>14</sup> System exploitation strategies seek to use national power to influence the adversary's cost/benefit calculus, either by dissuasion or coercion. In human system terms, dissuasion strategies involve the use of military power

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14. Allison et. al., *Essence of Decision Making: Explaining the Cuban Missile Crisis* (London: Harper Collins, UK, 1971), pp. 16-18, 143.

to block an adversary's course of action without actually imposing a cost on the adversary. The North Atlantic Treaty Organisation (NATO) operation in Bosnia prior to Deliberate Force was Deny Flight. This operation was intended to dissuade the Bosnian Serbs from attacking the Croats and Muslims simply by the physical presence of NATO forces between both sides of the conflict. Coercion is the employment of a system disruption strategy, but the primary aim is psychological effect, not physical influence. When the decision-makers are not rational, coercion may fail, as decisions are not made on the basis of cost/benefit analysis, but on some other basis. In these cases, it may be necessary to adopt the system destruction strategy, described earlier.

Both Operations Deliberate Force and Allied Force were primarily aimed at influencing the adversary's cost/benefit calculus by increasing the costs of continued action by the adversary. In the case of Deliberate Force, the coercion was applied almost exclusively by inflicting pain upon the Bosnian Serb Army. In the case of Operation Allied Force, the coercion graduated from hurting the fielded force, to inflicting mild pain on the Serbian elite, to punishing Milosevic and his closest supporters. Operation Deliberate Force aimed to influence the Bosnian Serb leadership's will, using both military and political power. NATO specifically permitted sufficient connectivity between the decision-making leadership and the fielded forces so that the leadership had a complete and accurate picture of what was happening to its forces. This strategy was specifically aimed at influencing the adversary's will by exploiting the connectivity between cognitive and activity components, rather than specifically disrupting it. Air power disrupted C2 sufficiently to ensure that the Bosnian leadership was unable to respond militarily to NATO's action, whilst still remaining in contact with its commanders in the field. Political power (i.e. diplomacy), was interspersed with the use of military

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force to spell out the political terms the Bosnian Serbs would have to meet. The interplay between air and political power was at its most powerful when NATO 'paused' the operation on September 1 to permit diplomatic efforts between the Bosnian Serbs and the UN and Ambassador Holbrook. When it became obvious that the Bosnian Serbs were not meeting the UN-NATO demands, Deliberate Force was resumed. Ambassador Holbrooke observed, "If the bombing had not resumed that day, the negotiations would have been very adversely affected".

The Bosnian Serb government received a complete and accurate picture of the damage to its fielded forces and the size of NATO's military power, as well as its determination to use it. Initially, the Bosnian Serb government discounted NATO's threat. NATO's efforts to destroy the Bosnian Serb Army's heavy weapons, by besieging Sarajevo, were frustrated by the practical difficulties of locating, identifying and striking small, well-concealed and dug-in targets. This reduced the credibility of the threat, as did the physical and moral support it received from the Serbian government. However, a decade of sanctions had taken its toll on the Serbians' morale and political cohesion and convinced Milosevic to withdraw his support to the Bosnian Serb government in order to preserve his own political power in Serbia. This loss of alliance cohesion caused the Bosnian government to reassess its cost/benefit analysis of the situation, and, as the costs of its course of action rose, it was successfully coerced into agreeing to NATO's terms, despite having resisted them for so long.<sup>15</sup>

Operation Allied Force began as an attempt to coerce Milosevic by hurting his security forces in Kosovo. NATO's efforts to destroy the Serbian Army's heavy weapons in Kosovo simply drove them into hiding, making subsequent attacks largely ineffective. Milosevic was not coerced by the disruption of his fielded forces or the systems providing support to them, and the Serbians managed to sustain their ethnic cleansing action. NATO decided to exploit the links between the Serbian political and social systems. A decade of sanctions had caused a significant stagnation in the Serbian economy: per capita Gross Domestic Product (GDP) had roughly halved to £8,000 and unemployment was at about 50 percent. The electricity

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15. Steven Burg and Paul Shoup, *The War in Bosnia- Herzegovina: Ethnic Conflict and International Intervention* (1999), pp.328-360.

grids were severely damaged, 85 percent of Serbians had limited electrical power, and the water supply to Belgrade was under threat. The business premises owned by Milosevic and his closest supporters were destroyed and income from smuggling activities was reduced, quite unintentionally, by the destruction of bridges. NATO's actions increasingly threatened to bankrupt the Serbian elite, who, in response, sent their families out of Yugoslavia and put considerable pressure on Milosevic to capitulate.

In Milosevic's cost/benefit calculus, the decision by NATO's leaders to forgo the threat of a ground invasion meant that NATO's threats were not credible. The mounting damage caused by the air campaign, NATO's increasingly convincing statement about a ground invasion and increasing internal political pressure, gradually raised the cost to Milosevic's position of power, of holding onto Kosovo. Additionally, his failure to destabilise neighbouring countries or split the alliance<sup>16</sup>, signalled to Milosevic that the tactical tide was turning against him and his own defeat was inevitable. Milosevic decided that he did not value Serbian control of Kosovo above his own survival. As with Operation Deliberate Force, the support of Serbia's Russian ally played a key role in the outcome of Allied Force. Initially, Russia was a strong supporter of Milosevic, but as the conflict progressed, Russia grew increasingly willing to cooperate with the US in the pursuit of a diplomatic solution. Possibly, the final straw was Moscow's silence in response to the indictment of Milosevic for war crimes on May 25, 1999. This eliminated any remaining chance that Russia might change course and resume its support for him. Capitulation became his best course, both to minimise further damage to Serbia and its military and to secure his position in power while NATO and the UN were still willing to talk with him.

As all the adversary's systems have a cognitive component, they are all liable to psychological influence. During Desert Storm, some Iraqi power plant managers took their plants off-line in a preemptive move in order to preclude damage and the coalition specifically planned to convince the Iraqi population to rid them of the Ba'athist regime by disrupting the electrical

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16. Ivo H Daalder, et. al. (2000), p.202; Judah (2000), p.271; Lambeth (2001), p.xiv; and Ivo H Daalder, "Hard Choices: National Security and the War on Terrorism," *Current History*, December 2002, pp. 409-413.

and telecommunications facilities. This was supposed to demonstrate to the people of Baghdad that the Iraqi president was powerless to counter the US air offensive. The planners wanted to “make [every Iraqi household] feel they were isolated. [we] didn’t want [the Iraqi people] to know what was going on.” There is no hard evidence that using air power to turn out the lights in Baghdad broke the population’s will or affected the population’s attitude toward Saddam and his regime in any significant manner

In Operations Desert Storm and Allied Force, considerable efforts were made to apply psychological pressure on the decision-making calculus of all individuals in the fielded forces. In addition to heavy bombing of ground formations, with substantial numbers of dumb bombs, to create fear, more overt psychological pressure was exerted through leaflet deliveries, and television and radio broadcasts. During Desert Storm, up to 100,000 troops, 30 percent of Iraqi soldiers, deserted. During Allied Force, troop desertion rates reached 300+ per day and an increasing numbers of Yugoslavs evaded reserve call-ups. Post World War I, strategists like Douhet and Mitchell had advocated bombing centres of population in the belief that the fear that this would cause would make the people force their governments to give in. However, the bombing of major cities in World Wars I and II failed to break the will of the people. Moreover, the deliberate targeting of non-combatants is illegal under international law, although this is a core strategy of terrorist organisations.

### **SYSTEMIC PARALYSIS**

A system paralysis strategy aims to exploit the system’s self-regulation capability by overwhelming it.<sup>17</sup> Boyd provides an excellent description of how this effect is achieved in his OODA loop model. In the context of the human system model, the “menacing environment” that Boyd desires is achieved by using air power to disrupt outputs. The disruption of an output will propagate to all downstream activities and indirectly affect the downstream activity through the input and resource dependencies. Indirect physical effects may also cascade upstream as those upstream activities are affected by the changes in the use of their outputs. More importantly, the

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17. William Lind, “4th Generation Warfare and the Dangers of Being the Only Superpower: A Warning from Clausewitz”, *Counterpunch*, March 8, 2003.

cognitive component will start to receive performance information about changes in outputs and will try to match the pattern of changes to those learnt or experienced before. Based upon the degree of match, the cognitive component will make a judgement about what is happening and decide how to adjust outputs in response. "Rapid and repeated combinations of ambiguous, but threatening effects, and deceptive, but non-threatening ones" will reduce the accuracy of the match and lead to increasingly inappropriate responses. If the speed at which the cognitive component process information falls below the speed at which it receives it, decisions are more and more likely to be out of touch. Inappropriate controls will result in mismatches among inputs, outputs, controls and resources that the adversary must eliminate if decisions are to result in actions that enable him to adapt to such an environment. If the adversary cannot do this, his reactions become totally inappropriate to the situation and paralyse his ability to reorientate to a rapidly changing environment. The inevitable consequence of failure is chaotic behaviour in the activity component, and decision-making paralysis in the cognitive component that will result in defeat.

### **MODEL SUMMARY**

Each case study operation used air power to prosecute one or more of the strategies described. In all cases, air power's kinetic effects were used, either just for physical effects, or to initiate a cascade of physical and psychological effects. Peace support operations appear in the conflict continuum, but were not specifically covered in the case studies. Despite the concentration of air power roles on offensive capability, air power plays a critical, non-combatant role in these operations, where its speed and reach make it ideal for the rapid deployment and projection of national power at the strategic level. Thus, using the human systems model approach, the separate theories for the employment of air power can be viewed as specific zones of a continuum of strategies to influence an adversary through will and means, using high or low levels of national power

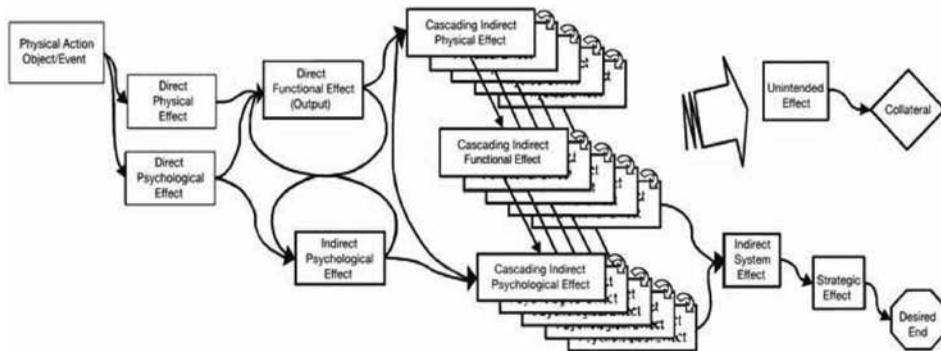
### **IMPORTANCE OF EFFECTS CASCADE AND CENTRES OF GRAVITY**

On of the advantages of the human systems model over Warden's 5-rings

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model and Boyd’s OODA loop is that it provides a tool for predicting the route of cascading of physical and psychological effects, as they must travel along the links between activities and the activity and cognitive components (see Fig 8). Planners can ‘shape’ the effects of air power by knowing which elements and links need to be preserved for the effects cascade and which need to be disrupted to initiate it. Effects must be shaped to influence the CofG consistent with the desired political objectives. Analysis of elements and links is necessary to identify their relative importance to the CofG, their vulnerability to kinetic and non-kinetic effects and the permissibility of applying national power against them.

**Fig 8: The Cascade Effect**



Source: Adapted from Smith, 2002, p. 31, and Enderby et al., 2002, p. 33.

Overall, focussing air power on influencing the adversary’s means is a less effective use of air power than influencing the adversary’s will, because its effect is primarily constrained to the operational level. Air

power was particularly effective when the effects created by its employment were able to cascade through the adversary's systems. However, the complexity and non-linear response capability of human systems means that it is very difficult to analyse the effects cascade and the adversary's strategic response. This analysis differs slightly from Operational Net Assessment (ONA) in that the primary focus of ONA is on the targeting of physical nodes to achieve effects, whereas the human systems approach is focussed on understanding system activities and outputs; the selection of physical targets occurs after the desired effect cascade has been selected. Both forms of analysis require a very high level of information about the adversary. Sun Tzu's dictum, "know the enemy and know yourself; in a hundred battles you will never be in peril" is even truer in the modern age. The human system model indicates that the most effective way to employ air power is to approach each adversary as a unique rather than generic opponent, conduct detailed analysis of his systems to identify the inputs, resources and decisions that are critical requirements for the CofG, and tailor a campaign plan aimed at attacking his critical vulnerabilities that enable the application of air power to have decisive effect.

**Despite the concentration of air power roles on offensive capability, air power plays a critical, non-combatant role in these operations, where its speed and reach make it ideal for the rapid deployment and projection of national power at the strategic level.**

#### **OPERATION INHERENT RESOLVE**

This is the latest battle in the Gulf wherein terrorist groups from all over have gathered under a single flag to form a Caliphate. They have six battalions worth of troops with independent C2. Hence, a case of multiple CofG. They also change the local commanders catering for the drone attacks. They are highly motivated and are well versed in air attack strategy. Albeit it is too early to draw any lessons, one can state comfortably that a wrong template has been used.

### **CONCLUSION: THE UTILITY OF THE HUMAN SYSTEMS MODEL**

The human systems approach is an all-encompassing construction offering an explicitly holistic view of the adversary as systems, links and elements. The model also provides a conceptual framework for understanding the cascade of direct and indirect physical and psychological effects through systems. This provides the starting point for detailed campaign planning by helping planners categorise the elements and links of an adversary's system. This enables them to visualise the CofGs that may exist at the strategic, operational, and tactical levels. Campaign planners can then analyse critical capabilities, requirements and vulnerabilities and conceive means to influence them in a way that will achieve political objectives. Political objectives and the properties of the CofG guide the selection of national power needed to induce effects, and the level of force to apply, if any. The range of strategic options identified by the human systems model, and their varying effectiveness, indicate that it is important that the application of force on a critical vulnerability be directly linked to influence on a CofG. In turn, the disruption, destruction or neutralisation of a CofG must be coherently linked to the desired political objectives. A key strength of the human systems model is that the interdependence of the cognitive and activity components overcomes the tendency of Warden's approach to assume that a 'template' campaign can be applied to any adversary. Implicit in Warden's model is that an adversary will comprise broadly the same systemic construction as the United States and that the adversary's systems are 'static', unresponsive. The human system model inherently assumes that an adversary's systems are unique and can respond to attempts to influence them. This requires military planners to anticipate the dynamic interaction of friendly and adversary powers and likely adversary courses of action. Finally, it overcomes the criticism of Boyd's OODA loop model that it provides no practical guidance for the implementation of coercive or paralysis strategies. However, the human system model provides guidance on what has to be done, but the operational art is still the preserve of the commander's judgment.

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