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PROJECT MANAGEMENT FOR COMPLEX AEROSPACE FACILITY WITH MULTIPLE DOMESTIC AND INTERNATIONAL AGENCIES USING A NOVEL TOOL

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ABSTRACT

Complex Projects need innovative thinking and the State of Art Management Practices. The Military Project Management requires a multifaceted approach in the complex Technology environment to ensure Security of the Country. There is an essential need to ensure delivery timeline within the allotted budget. This assumes greater challenge for first time Indigenous design, development, and production of Carrier-Based Fighter (CBF) Aircraft. In order to test and qualify CBF, there was an emergent need for the Shore Based Test Facility (SBTF). This being National Project, there were severe time constraints and it was under close scrutiny for implementation. The Project required a complex engineering task of arresting the descent of Aircraft at microsecond accuracy. This simulates the actual landing in ship deck and hence qualifies the Aircraft arrestor hook system, which is indigenously developed. It also simulates takeoff from Ski-Jump to qualify the aircraft in an actual operating environment. The SBTF Project involved management of foreign collaborator, planning and execution with countless reviews and applying correctives measures. This paper deals with the planning and execution of the SBTF Project and use of a Novel Management Practices for the same. The SBTF Project was successfully executed in Jan 2014 and effectively employed for indigenously developed CBFflight testing and training ofIndian Navy pilots on existing Russian MiG29K Aircraft. The SBTF Project is reliably ready to prove Carrier Compatibility of indigenously developed CBF and train Indian Navy Pilots.

KEYWORDS: *Management Practice, Carrier Based Fighter Aircraft, Shore Based Test Facility, Complex Aviation Technology, Nine Point Framework*

INTRODUCTION

It has always been a challenging task to develop Aircraft for Naval application, due to stringent consideration of takeoff and landing requirements of the short Ship deck runway length, of less than a quarter of kilometer, without compromising any performance as a Fighter Aircraft, unlike a conventional Air Force Aircraft, which operates from ground-based long runway strip of several kilometers. The development of Shore Based Test Facility (SBTF), which is a static replica and almost equivalent to buried Aircraft Carrier, on the ground for the purpose of carrying out Naval Specific Aircraft tests with an added advantage of training platform for Indian Navy pilots, is a challenging technical and managerial task. The paper focuses on the managerial aspects of the project planning, execution, and monitoring.

THE NEED

The requirement of building SBTF was envisaged to test and qualify the indigenously developed Carrier Based Fighter (CBF) Aircraft prior to its operations from actual Aircraft Carrier at Sea. Since no Naval Aircraft can be realized without shore-based flight test trials, the need for such a facility is of Strategic importance for our Country. Such a facility would avoid the need for actual Ship and avoid the damage, both to Aircraft and Carrier, which are very costly and precious National assets. Currently, Russian made Aircraft Carrier INS Vikramaditya is fully operational and Indian Navy long term perspective plans include construction of two Indigenous Aircraft Carriers (IAC), namely INS Vikrant and INS Vishal. The replacement of age-old Sea Harrier Vertical and/or Short Take Off andLanding (VSTOL) Aircraft with Short Take OffBut Arrested Recovery (STOBAR) Aircraft like indigenously developed LCA Navy and MiG29K are the future of Naval sea supremacy. The concept of development of Project SBTF was around the STOBAR concept, similar to INS Vikramaditya and INS Vikrant. One can appreciate the technical complexity and equipment density onboard an Aircraft Carrier from Figure -1. The figure compares standard runway at INS Hansa, Goa with the length of SBTF deck runway and Aircraft Carrier INS Vikramaditya.

Figure 1: Runway Comparison: INS Hansa, SBTF and INSVikramaditya

The constraints on the Aircraft Carrier will dictate various operations onboard the Ship deck and around it. Under such an environment, the Aircraft design requirements will be extremely stringent and pose great challenges to the designers, builders and certification agencies. The basic Naval STOBAR Aircraft requirements are enumerated below, as per the International Military Standards:-

- Take-off from Ski-jump and deck run of about 200 m.
- Arrested recovery with Arrester Hook System (AHS).
- Strengthened landing gear and Aircraft structure for maximum landing loads sinkrate and longitudinal deceleration.
- Adequate cockpit vision for the pilot as per Military Standards.
- Fueljettison system for emergency Carrier deck recovery.
- Aircraft with In-flight refueling capability, preferably with a retractable probe.
- Aircraft dimensions and weight to suit the Carrier lift dimensions.
- All weather day and night operations from the Sea environment.
- Engine start time and acceleration response time.

PROBLEM DEFINITION AND FORMULATION

The problem defined was to:-

a) To have a Single View Framework for both Project Execution and Monitoring.

b) To Conceptualize, design and realize the Shore Based Test Facility (SBTF), which includes site selection and various vendors/partners.

Choice of Single View Framework

Based on the above Strategic National need, the problem was to conceptualize, design and realize Shore Based Test Facility (SBTF) within the given timeline and approved budget provisions. The specific challenges were to meet a stringent schedule with widely spread International partners and domestic agencies, and within the allocated budget in Indian rupees and foreign exchange, in the overall environment of uncertainty. For this purpose, a survey was made, as to How complex technical projects are efficiently executed ? In view of the strategic nature of the project, there is hardly any published literature on the topic. Salapatas, James N, a concept of Nine Elements to the success of Project Management was appealing [1]. Instead of having numerous benchmarks which could dilute the main focus, following the model of nine interrelated elements was adopted, as the Single View Performance tool. This concept was utilized for project planning, execution, and monitoring

- Defined life cycle and milestones
- Stable requirements and scope
- Defined organization, systems, and roles
- Quality Assurance:
- Planned commitments
- Tracking and variance analysis
- Corrective action decisions
- Escalation and issue management
- Work authorization and change control

Options for Setting up SBTF

Apart from the decision to go with the Russian design, alternative options for setting up SBTF were also explored. The possible sources were US Navy, Ukraine and a firm in the UK as explained below :-

- Indigenous Development: Initial exploratory work to undertake indigenous development within the best available in-house recourses, revealed a lack of matching capabilities to meet the requirements.
- US Navy: US Navy has Shore-Based Aircraft Carrier Environment Test Facility at Patuxent River, Maryland, and Lakehurst, New Jersey. All equipment is manufactured in-house by the US Navy. On an enquiry on, whether they may be willing to support India for SBTF ?, They indicated that lead time would be at least 5 years, even if approved by the US State Department, due to their internal requirement of lead time. This in effect was not a viable option, unless the indigenously developed CBF Aircraft is taken to the US for testing to expedite the flight testing.
- NITKA Test Facility, Ukraine: The NITKA Facility at Ukraine, satisfies the major requirements of indigenously developed CBF Aircraft testing and Indian Navy pilot training, but due to the uncertain political environment between Ukraine and Russia, it was not feasible to take-up contract with Ukraine.
- Mc-Taqqart Scott, UK: Scotland based firm supplied arresting gear for the erstwhile aircraft carrier INS Vikrant, in the 1960s, capable of handling lighter aircraft. They have not made any arresting gears since then.

Option Analysis and Selection

Detailed analysis of all available options was undertaken and the report was made. The requirement of setting-up SBTF was critical and urgent to undertake flight testing of indigenously developedCBF Aircraft. Keeping in mind the

uncertainty and expected delays, the possibility of going ahead with the above options were ruled out. India has long-standing and well-proven defence cooperation with the Federation of Russia and it was decided to take up the matter with them. As INS Vikramaditya contract was already signed, it was added advantage that similar equipment specifications will be delivered by the Russian side. Thus, it will fulfill the primary objective of indigenous CBF Aircraft flight testing in a realistic operational environment. It was also envisaged that having Russian based SBTF will additionally help Indian crew training on already existing Russian deck-based fighter Aircraft, MiG29K. The matter was pursued accordingly and the Russian side agreed to provide cooperation for setting-up SBTF.

Project Planning

Detailed discussions were held with all the International and domestic partners towards the execution of the project within the constraints of timeline and allocated budget. The concept of nine elements was briefed to all the stakeholders towards the success of project management. All the stakeholders agreed for the frame-work so as to ensure well-focused approach for the project execution and monitoring. This will avoid dilution of focus if we have numerous benchmarks.

SELECTION OF LOCATION

The detailed plan for Facility build up was made. A thorough study of available locations was carried out including geological survey, meteorological survey and size of land required. The availability of large land piece, with favorable metrological conditions, was main considerations. Additional points regarding, Aircraft manufacturing location, distance, and logistics requirement for supporting operations were also carefully studied.

- The Aircraft is manufactured at Bangalore and operationally flown from Aircraft Carrier from Goa sea area.
- Communication with Headquarters and quick technical support would be required on frequently during facility development and aircraft deployment.
- Ability to quickly deploy technical and support manpower and equipment.
- In crisis times, the ability for the pilot to quickly practice or refresh before commencing operations.
- Need for robust and failsafe communication facility for flight operations.
- Availability of land, water, and Electricity with favorable wind conditions and operational safety.

Considering the above points, a criteria-based critical analysis was made. The formal and informal consultations were undertaken with over 500 operational stakeholders involving designers, manufacturers, builders, pilots, military strategists, maintenance and other support crews. A detailed Matrix was prepared of criteria points with weightage and finally, Goa was chosen as the location for setting up the Shore Based Test Facility (SBTF).

TECHNICAL REQUIREMENTS FOR SBTF

The developmental processof CBF Aircraft for the navy is through concurrent development and flight tests program is indicated below:-

- Determining developmental test blocks.
- First Block of Flights (FBoF).
- Carrier Compatibility Test (CCT).
- Initial Sea Trials (IST).
- Follow-on Sea Trials Phases (FST).
- Initial Operational Capability (IOC) Demonstration.
- Full Operational Capability (FOC) Demonstration.

The SBTF should be able to fulfill requirements for the flight test program to achieve stepwise certification of the CBF Aircraft. As CBF Aircraft for the navy is developed from Air Force LCA Tejas program, many tests may not be required to repeat as a part of certification/clearance hence Carrier Compatibility Tests is the largest scope of work and covers major test points on takeoff and landing performance. The Carrier Compatibility Test of CBF Aircraft drives the basic requirements for the design of SBTF [2,3], similar to Aircraft Carrier and the same is indicatedbelow:-

- Arresting Gear System.
- Ramp with suitable exit angle.
- Restraining Gears hold back hydraulic chocks.
- Optical Landing System.
- TV Monitoring System.
- Lighting System for night operations.
- Telemetry setup with monitoring.
- Sufficient landing runway with control post.
- Freeroll distance for the takeoff run with control post.
- Upper deck Ship markings.
- Favorable wind and temperature conditions.

The requirements of SBTF was communicated to all down line and executing personnel, including workers as it would enable them to perform better and the Inspection team can quickly take a decision on clearance or rework or rejection. This, in turn, freed the top managerial team to focus more on project goals.

ANALYSIS OF SELECTED OPTION

As a long-standing strategic partner Russia side came forward to support the critical need of India and Contract was signed between Russians and Aeronautical Development Agency (ADA), MoD, Bangalore for setting up of SBTF,Goa. Few additional supplements were also signed for supply of specialized equipment and provide detailed design consultancy. The overall scope of Contract included buildup, installation, setting to work, testing and commissioning. Also, the aspect of training, operations, and maintenance was included. It was a large scale complex Project with peculiarities of International cooperation in the Military environment. The Indian Agencies were also identified for Specialized civil work and ship fabrication. Indian Shipyard was assigned the task of Shipbuilding, equipment installation and outfitting. Meticulous and efficient Project coordination further became crucial as there were about 20 Russian and Indian Agencies involved with varying responsibility towards Project implementation. Thus, the role of ADA as a Nodal Agency for SBTF development is critical to ensure successful completion with the allocated budget and stipulated timeline. Figure 2, comprehensively depicts conceptualization, approval, and execution of Project SBTF. It also indicates various essential steps, objectives fulfilled and advantage accrued to the Indian side. SBTF is a critical national asset and was required urgently. It was imperative that the timeline is kept in focus without exceeding the allocated budgetary provisions. The concept of concurrent design and development was the way ahead for the success of Project SBTF and it was used to the fullest.

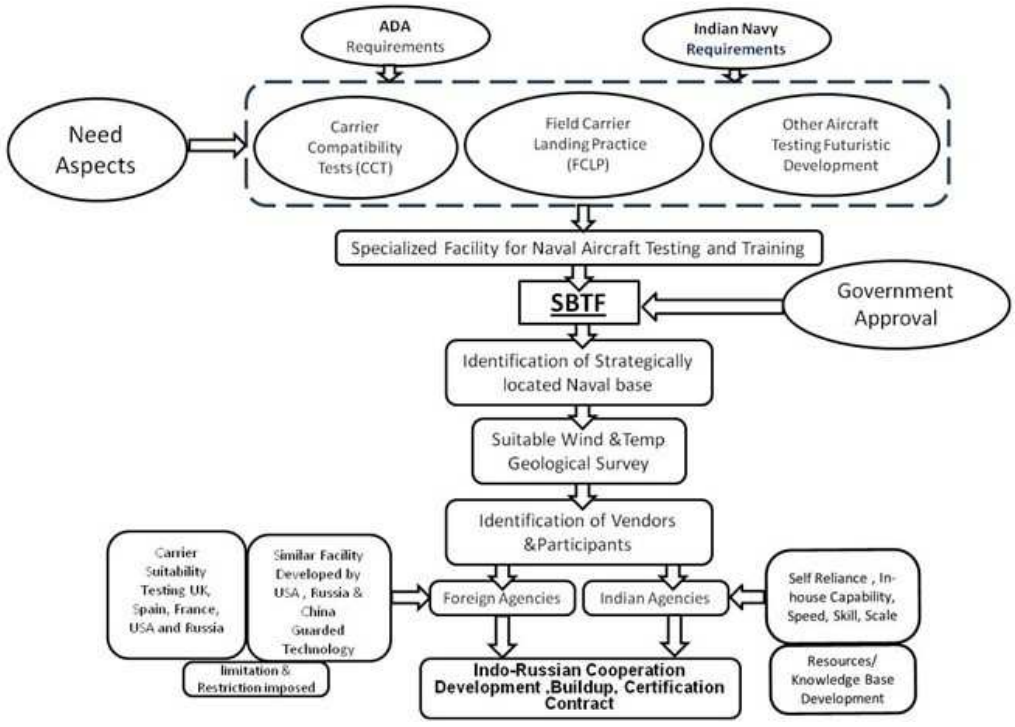

Figure 2: Conceptualization of Project SBTF

POJECT PLANNING: PROBLEM FORMULATION AND SOLUTION

SBTF is a complex technical project, involving many widely spread, International and domestic partners, and it became imperative to draw a Novel management plan [1]. A judicious amalgamation of traditional CPM and hierarchy empowerment was essential. Management controls were distributed and various stages of the hierarchy were empowered with focus on nodal point activities.

Extensive usage of various management techniques and software tools were used for plan and monitor coordination of activities [4,5,7], with baseline as nine element framework [1]. The project management structure is shown in Figure-3 [2,3]. Software tools with the help of available data ensured efficient project implementation. CPM technique was used extensively, at every stage to assist management for decision making. SBTF being large and complex Project, CPM provided all key information at every stage and path to facilitated project evaluation. It is extremely important to critically define, analyze and suitably interface all the activities of various players for smooth implementation of the project. Figure 3 depicts the complex interface of various Russian and Indian agencies for the scope of responsibilities, and its interface among others [2,3]. It can be easily appreciated that with widely dispersed agencies and complex technical work interpersonal, cultural and language management was an important aspect of the project execution [1,7].

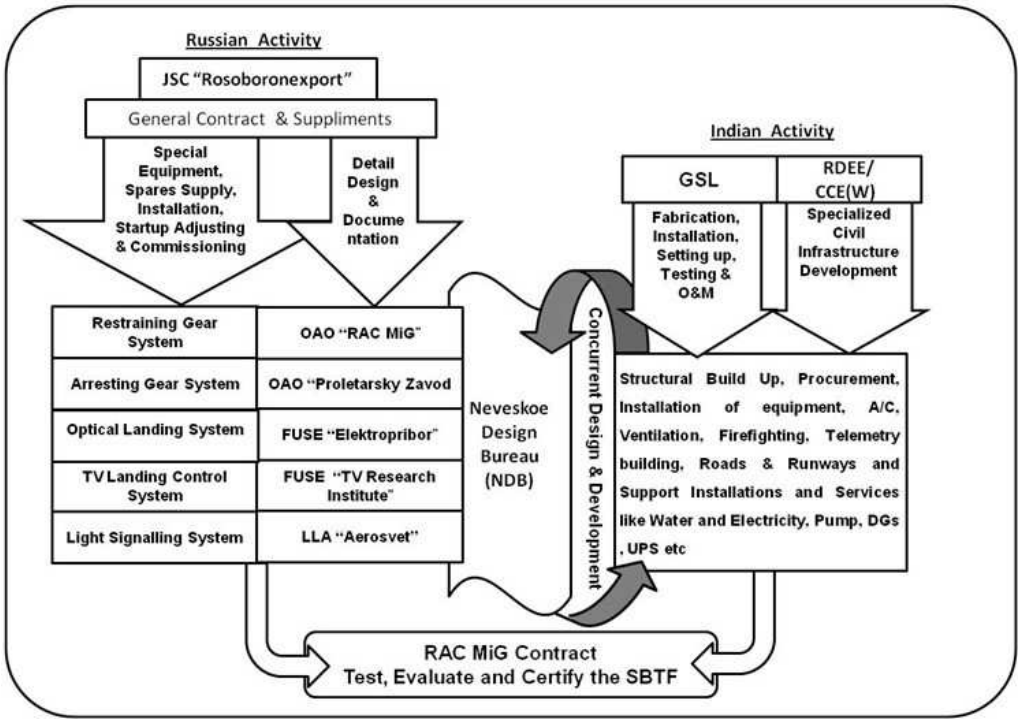

Figure 3: SBTF Development Interfacing of Russian and Indian Agencies

The combined effort by Russian and Indian side ensured smooth contract compliance and fulfillment of required quality by Russian/Indian agencies for activities like the supply of equipment, installation, testing, calibration and certification as per schedule and resolved many technical issues on site. A large number of technical and administrative issues were encountered ranging from security, entry to the restricted area, late night working hours, Visa and security aspect of foreign nations including a supply of food items. Technical issues were compounded by high-temperature variation and incessantrains on-site. Typical on-site technical issues like mismatching of drawings, interference of pipe lines, cables, ropes, pulleys, inaccessibility to space for welding, cement, and interfacing were observed. Many civil structures and metal integration precision work were done first time in India and innovative methods with monitoring management tools were employed to achieve successes. Overall, each Russian and Indian stakeholder contributed significantly for the timely completion of the prestigious SBTF Project.

The genesis of CPM is indicated below in Figure 4 and Figure 5 [2,3] with key activities and duration. Table 1 indicated a description of key activities of Project SBTF, however, description of certain micro activities has not been provided in the table, due to the classified nature of the project. CPM charts were meticulously prepared and discussed in detail at the beginning of the project and reviewed periodically. The Charts has been made with key activities and micro activities were defined in detail. The collaboration structure and project execution mode conceptualization was evolved based on the following principles:-

- Time schedule cannot be compromised at any cost.
- Virtual road map from start to finish.
- Back-calculation from the given project timeline, after giving slack time and accommodating project module slack times.
- Control Mechanism put in place to keep vigorous watch on project progress.

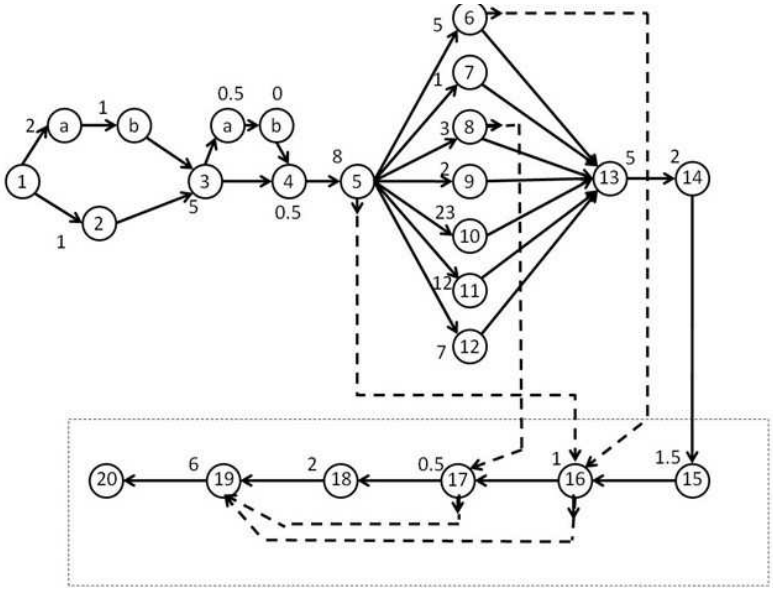

Figure 4: CPM Chart for overall SBTF Activities

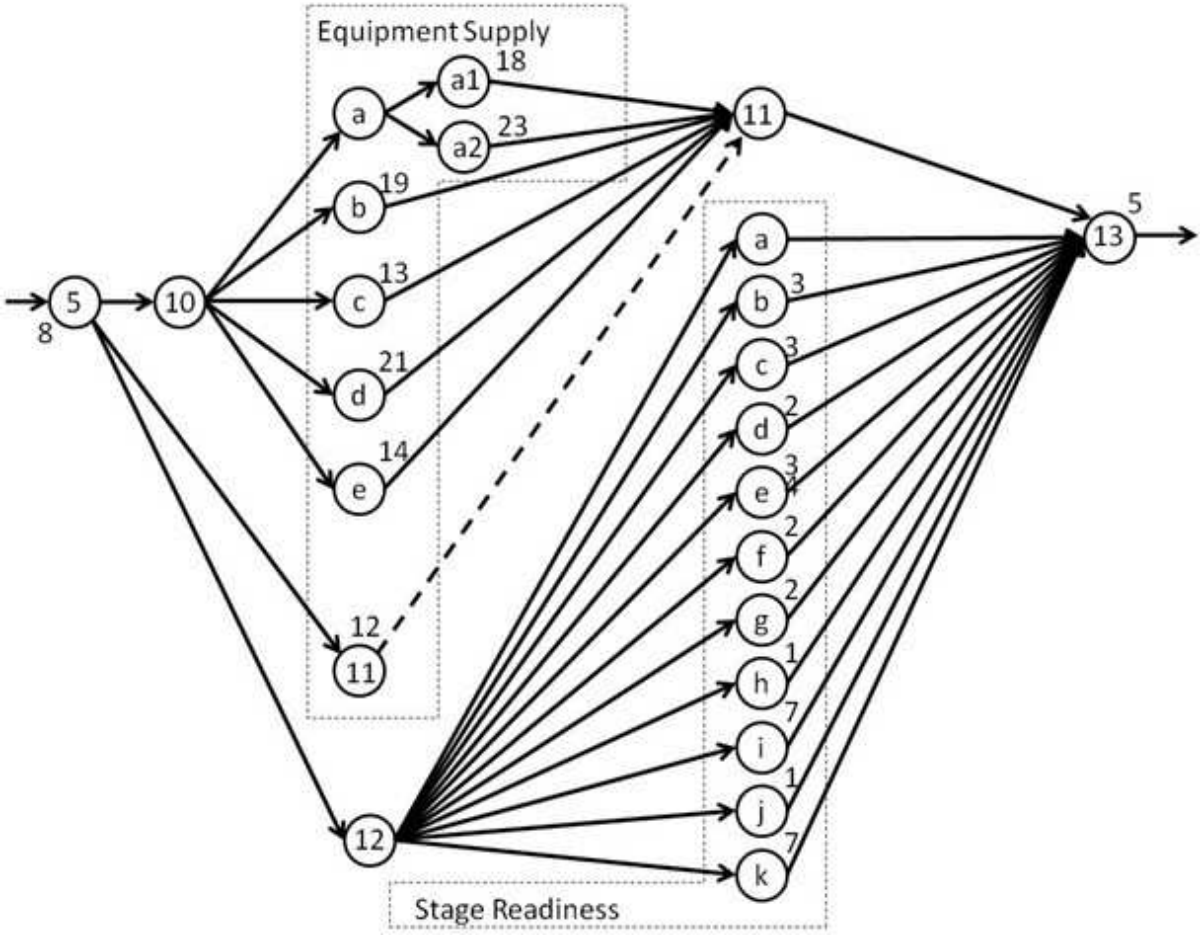

Figure 5: CPM Chart for SBTF Activities

RESULTS AND DISCUSSIONS

There was operationally critical and urgent need to set up Shore Based Test Facility (SBTF) in India for Carrier Compatibility Tests (CCT) of indigenously developed Carrier Based Fighter (CBF) Aircraft for the Indian Navy and Field Carrier Landing Practice (FCLP) for Indian Navy pilots on MiG29K/CBF Aircraft. This urgent need has been fulfilled with a unique management model. A novel project management tool of nine element framework was successfully implemented for the present national project. The concept has worked well without time slippage and cost escalation. In house availability of ProjectSBTF will provide the necessary impetus to the ongoing and future CBF Aircraft projects. Additionally, this unique Facility will provide self-reliance, speed, scale and scope of CBF Aircraft design activity.

The project was successfully completed instipulated time and allocated budget, thus timeline slippage and budget enhancement was nil. The project successes were achieved by rigorously following nine-point Novel framework and complete focus on the target with having readymade redundancies alternate plans at every sub-stage levels of the project. Nothing was taken as given and even the vendor's commitment was not taken for granted. Instead, a robust verification process and alternatives were put in place. The key to the success was the conceptualization of CPM chart and having a template for informing project status on real-time and the special focus on negative variance with prompt corrective action.

Table 1: Description of SBTF activities

No	Activity Description
1	Contract signature
2	Initial data gathering by stakeholders
3	Finalization of a manufacturing plan
4	Design review
5	Working document readiness
6	Operational document readiness
7	System test plan
8	Delivery acceptance document readiness
9	Delivery test plan
10	Manufacturing and supply of Russian equipment
11	Manufacturing and supply of Indian equipment
12	Construction and mounting work
13	Installation and start-up work
14	Acceptance of work
15	Trials of equipment and systems
16	Operational document correction
17	Trial documentation
18	Final technical documentation
19	Commissioning of SBTF
20	Contract closure

CONCLUSIONS

The success of the Project SBTF validates the concept of Novel management tool of nine-point framework and adequately proves the concept. Such an approach can handle uncertainty, especially with International vendors and large numbers of stakeholders. It has shown that the approach of work modularization of project based on sound technical judgment is essential. Robustness of the approach is well proven by adherence to timelines and budget allocation.

The SBTF Project has provided valuable experience to Indian Side in understanding Aircraft Carrier technology and building multi-organisational / multi-national complex projects. Also, Indian Agencies like Goa Shipyard Limited (GSL) has gained experience of outfitting unique Russian equipment, its operations, maintenance, and repairs, in addition to specialized civil work concepts. Also, such exposure will help INS Vikramaditya equipment, in case of need, by GSL. Further, such experience will be valuable for Indian Aircraft Carrier development programme in the future and also provides a template for time bound project conceptualization to execution.

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