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INDIGENOUS JET-ENGINE DEVELOPMENT – INDIA AT CROSSROADS

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As India stands at the crossroads of decision-making about the development of indigenous jet engines, it is appropriate to remind ourselves that the value of the decision-making process lies in making a timely decision rather than deferring it for the sake of taking the correct one. That said, one needs to dig deeper into the causal factors for the delayed development of indigenous jet engines – Kaveri project (see figure 1). The brief attempts to analyse the factors behind the much-delayed project and a proposed roadmap to tide over the issue and retain optimum deterrence in terms of airpower.

Present Status

Chinese advertisement of its sixth generation fighter aircraft has brought the Indian fighter development project into the limelight once again. The most quoted causal factor for these inordinate delays in the project has been the delays on the part of the jet engine procurement/ acquisition. There appears to be a resurgence in the efforts of the Defence Research and Development Organisation (DRDO) and Gas Turbine Research Establishment (GTRE) to rekindle the Kaveri project; however, that would require a substantial capital investment.[1] The perceived thrust on Atmanirbharta against significant delays in the procurement and acquisition cycles leading to diminished operational effectiveness of the Indian Air Force (IAF) has brought the Indian polity and its decision-makers to a crossroads. Any yonder away, one may only find criticism. In this moment of reckoning, the validity of this argument lies in making a decision

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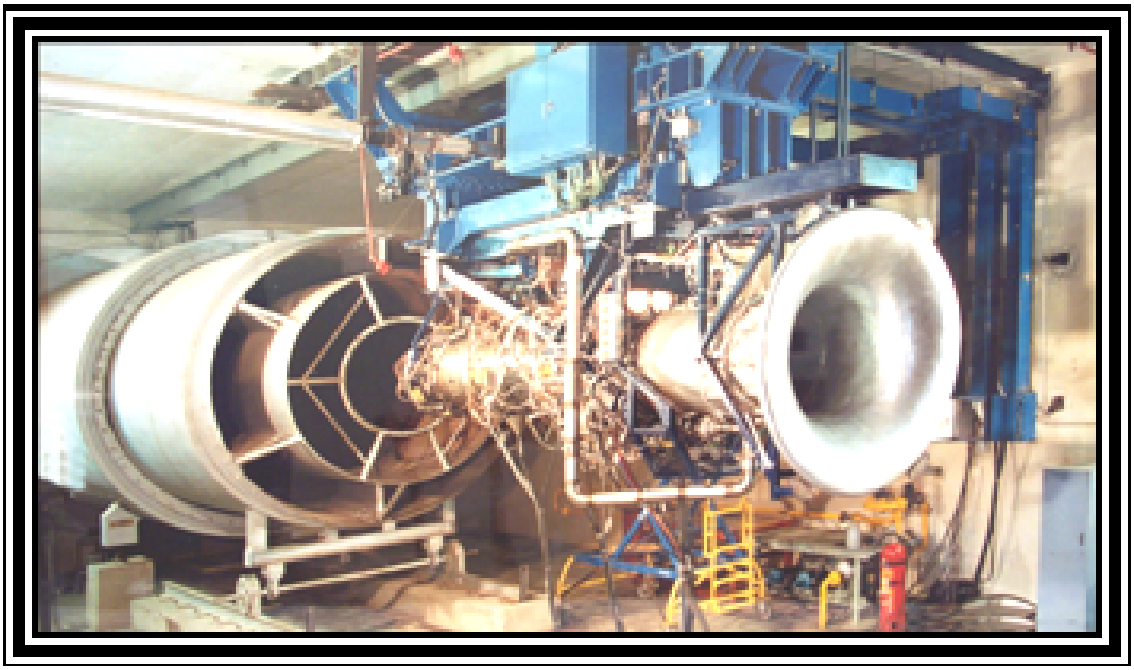
rather than ensuring the right one. Otherwise, we will be required to resort to options like the Rafale government-to-government deal that are expensive and inadequate.[2]

Figure 1: Kaveri Engine



Source: Defence Research and Development Organisation, "Kaveri," https://www.drdo.gov.in/drdo/technology-cluster-links/labs-products-detail/1323/173.

GTRE, a subsidiary of DRDO, was tasked to develop an indigenous Jet engine to power the Tejas fighter in 1986. A chronological assessment of the Kaveri engine project timeline indicates repetitive delays in the project (see figure 2). There are various reasons for these delays[3] These reasons are institutional and could have been mitigated with a proactive approach and stakeholder commitment.

Reasons for Delay

There are compelling reasons for these inordinate delays—generalising them would be unjust:

- *Limited Experience*- First, the jet engine is undoubtedly one of the most complex machines requiring advanced materials, precision manufacturing, and sophisticated design capabilities. A comparative analysis of the indigenous development of aero-engines worldwide compared to countries with established aerospace industries, such as the United States, Russia, or France, indicates that they are proprietary and limited in number.

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- *Need for Speed*- The geopolitical situation of the times (namely post-World War, Cold War, etc.) in which these were developed presented the developers with the urgency, impetus, and return on investment (ROI) they sought. In this regard, a timeline survey suggests that Indian decision-making authorities have found laying adequate impetus said development challenging. To be fair to the production agencies, the ROI prospects appear gloomy to pursue such efforts.

- *Funding and Resources*- Developing a jet engine requires significant financial investment and resources. Unfortunately, the Ministry of Defence (MoD) did not allocate adequate funds to GTRE to develop the aero engine. It did not provide funds to establish testing facilities like high-altitude testing or a flying test bed. Consequentially, GTRE had to rely on foreign companies for these tests, resulting in significant delays and increased costs.

- *Regulatory and Organisational Hurdles*- India's defence procurement and development process can be sluggish and bureaucratic, potentially delaying projects and stifling innovation. Another factor popular in social media is attributed to the organisational culture of our research and development (R&D) establishments.[4]

- *Intellectual Property and Collaboration*- Much of the advanced jet engine technology is held by a few countries, limiting access to crucial knowledge and patents. Just four to five countries have managed to develop it. No country is willing to share it. It must be developed through indigenous R&D, or some original equipment manufacturers (OEM) may be willing to collaborate in joint R&D at a considerable cost.

- *Testing and Infrastructure*- Developing and testing jet engines requires specialised infrastructure, including test facilities and skilled personnel. While India has not invested adequately in building testing facilities, it still lags behind more developed aerospace nations.

- *Focus on Other Areas*- India's defence strategy has often prioritised other areas, such as missile technology and unmanned aerial vehicles (UAV), which may have diverted attention and resources from jet engine development.

As the Chief of Air Staff pointed out, it is necessary for us to enter into the mission mode with an all-of-nation approach.[5] To summarise, to tackle this situation, one must identify and engage with all the causal factors and enter the mission mode. While these are the justifications quoted in the popular strategic communities for the project's failure to progress, there is an obligatory requirement to qualify each of them in the context of state

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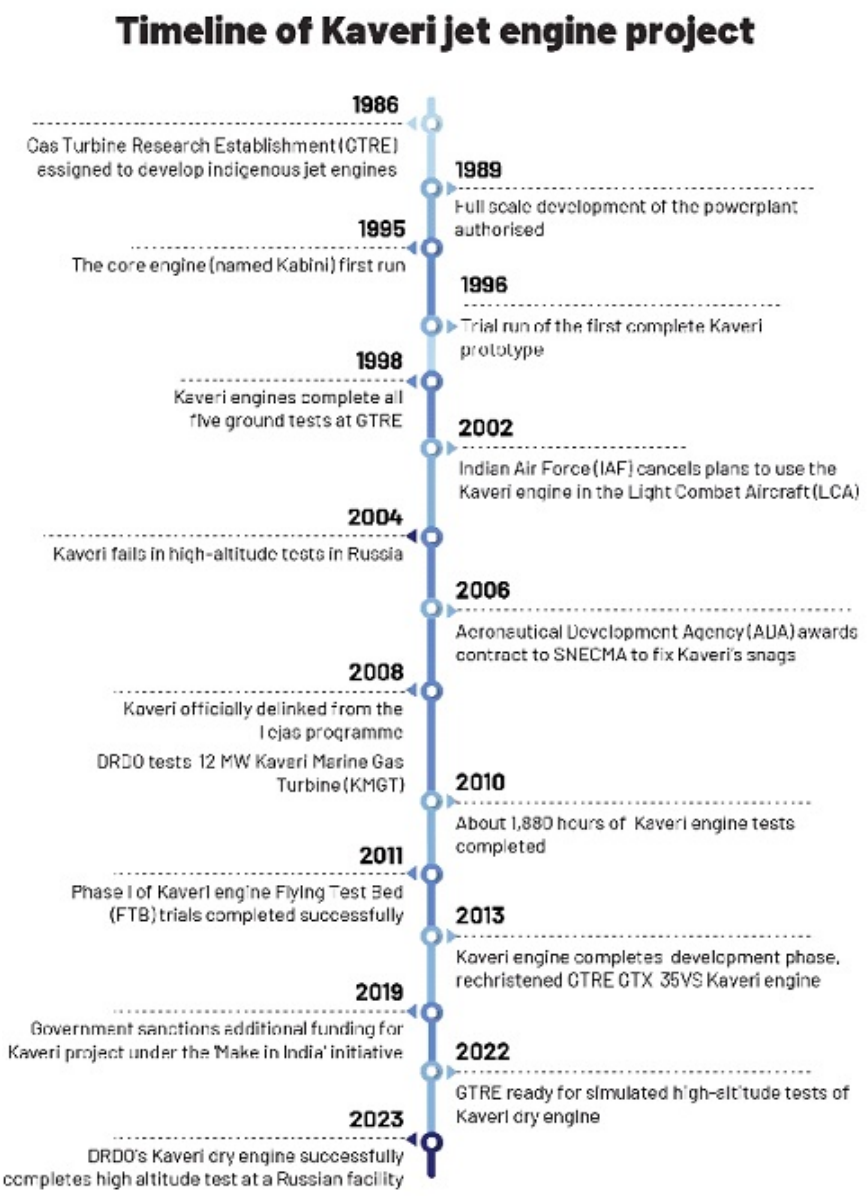
capacity, pressing geopolitical situation and concentrated attention on the part of the state mechanism.

Figure 2: Timeline of Kaveri Development



Source : CUTS International, "Project Kaveri and India's indigenous jet engine ambitions may remain in the cupboard," https://www.cuts-global.org/article-project-kaveri-and-indias-indigenous-jet-engine-ambitions-may-remain-in-the-cupboard.htm.

Cost of Decision

The development has already cost the exchequer INR 2,839 crore[6] until 2016, as brought out by late Defence Minister Manohar Parrikar in the Lok Sabha on August 12, 2016. The cost of the 99 F-404 engines deal likely to start in March to April 2025 is approximately INR 48,000 crore. Another INR 26,000 crore is committed towards 240 AL-31FP aero engines for Su-30MKI.[7] India is estimated to invest INR 1, 50,000 crore towards buying engines from multiple manufacturers.[8] The cost thus spelt out is all-inclusive, with proprietary and intellectual property rights remaining with

the manufacturer. It is appreciated that such outright buying would help keep the indigenous fighter program alive for the moment; however, in the long run, it is likely to be detrimental. Withholding/ diverting the funds towards such deals would also entail forestalling Indigenous engine development in both domains, including R&D and capacity buildup. Either way, the cost only rises by the minute, and indecision would entail further costs.

On the other hand, the cost of making a wrong decision can be calculated after a thorough analysis of the probability of failure. In any case, the proposal in subsequent paragraphs aims to diversify the options and mitigate the cost of failure. In this volatile, uncertain, complex, and ambiguous (VUCA) world, prediction can be hazardous, and the need for over-evaluation is persistent. One has to suppress this need, be bold and forego criticism that will come their way in whatever choice is made.

Options

Having established the scenario, it is pertinent to identify the options available to the decision-making authorities and validate them against the acknowledged processes. The various options available at the moment are as follows:-

- *Continuance/ Reinvigoration of Indigenous Plans*

The romantics of Atmanirbharta would say this is the only way to achieve military effectiveness in its true sense. The pros involve the development of capability, avoiding external dependence, strategic autonomy and financial benefits in the long run. The cons range from heavy financial burden with a possibility of catastrophic failure of the attempt, further weakening of air power and its deterrence capability, allowance for misadventure on the part of our adversaries and stalling of associated developments dependent on such a capability. All the evidence indicates that avoiding the Indigenous option altogether would be detrimental in the long run.

- *Importing under Industry Contracts/Government-to-Government Initiatives*

The growing opinion, especially in the civil parleys, backed by repeated failures by our development agencies, is regarding importing these jet engines as soon as possible to provide for the indigenous fighter development. The pros are immediately sustaining the indigenous fighter program, keeping the Indian air power deterrence capability alive, and building production capacity. The cons range from substantial capital requirements out of the defence budget and related shelving of other projects, as well as an apparent jolt to the 'Atmanirbharta' push, continued dependence on foreign agencies, and the prospect of adverse regulations in times of distress.

- *Collaborative Production Models*

The R&D agencies are keen on collaborative attempts to co-develop and co-produce these jet engines. The pros are the possibility of developing a jet engine in a much narrower timeframe based on the partakers' expertise, a sustained push to the indigenous fighter program and self-reliance in terms of nurturing the process ahead. Despite these efforts, it would still take approximately 10 years. The cons would involve the possibility of weaselling of the partner involved and, Foresta, telling the entire process, the dependence on the foreign player to commit to the said effort and the prospect of collaboration being driven on the external entity's terms owing to his proprietary expertise. The joint development would include knowing the entire process and IP rights. One would have to pay the foreign partner a lot to assist us in the engine's co-development.

Binding Parameters

As assessed, the importation of engines must be done to keep the indigenous fighter program going until the indigenous engine is developed. Therefore, there would have to be a multi-pronged approach. Certain imperatives that must be accounted for are as follows:-

- *Deterrence Capability of IAF*- The Indian air power must retain its minimum deterrence capability in terms of numbers and diversification of its offensive capabilities. It would require an intelligent juggling between these capabilities, training and management of funds, adequate foresight and, above all, an extensive review of these prospects with all stakeholders.

- *Thrust on Indigenisation*- The indigenisation effort has to remain alive even at the cost of diverting certain funds from efforts elsewhere. The MoD would be required to lead this premise, keeping the finance ministry on board. One of the most recurring arguments for the failure of the earlier attempts is the paucity of funds; hence, getting the financial management involved in the process is imperative.

- *Collaboration Models*- The collaboration model has to be adopted, keeping in mind our letdowns in the past that were based on limited expertise in such an endeavour. The existing models and apparatus have to be the commencement point of this effort. One must ensure that one is adaptable enough to build upon the expertise we have gained in the field despite all our shortcomings.

- *Competitive Business Model*- The jet engine development and defence capability development need to adopt a competitive business management model to achieve

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the desired results. The all-encompassing approach would ensure accountability, the dismantling of Silos and efficiency in the entire process. Policymakers must lead this effort to ensure commitment to the goal and continuity.

Suggested Roadmap

The following roadmap of the Indigenous engine development plan is proposed based on the aforementioned analysis, argument and urgency of the problem:-

- An independent committee to be set up under the aegis of MoD involving members of the Ministry of Finance, DRDO, GTRE, IAF, HAL, ADA and Centre for Air Power Studies. In addition, representatives from foreign engine manufacturers, Indian defence production agencies (existing and prospective, civil and govt), academicians from IITs and successful business management firms must be involved for their views and provide contemporary on-ground assessment. The committee must be mandated to complete the proposed acquisition/procurement plan in a prescribed time. The core of the committee must also form part of the management team to ensure the project's success. The committee needs to review the existing status, options available and underlying factors mentioned earlier. Dual-hatting in every manner must be strictly avoided by taking their bosses into confidence.

- The follow-up of the review would produce a certain quantity and quality of jet engines via multiple means. This proposal must cater to aspects of redundancy, production capacity development and scaling at the optimum time, development of in-house testing facilities, and capability to integrate developing technologies on the go. Digital twins, augmented reality/virtual reality (AR/VR) modules, and automated response modules must be part of the project at the onset.

- As the process moves onto the business end, the core committee needs to don the hat of management to ensure continuum and accountability. Management concepts of regular reviews and project-based deadlines like PLI must be adopted.

- The whole process needs to base its engagement with media and external entities on a need-to-hide theory rather than a need-to-hide basis. This intends to invoke interest in the general populace and industry, fair trial of the entire process and adoption of innovative ideas in the field. This would be akin to an unpaid watchdog ensuring accountability to the process.

Conclusion

Such an approach would ensure results are sought with a sense of realism attached to the entire process. Despite the current limited competition in the whole mechanism,

such an adoption with adequate transparency would appeal to more participation from all players, big and small. With the involvement of the core committee in the management of the entire process, it is envisaged that the process would be efficient and result-oriented.

However, as one returns to the opening argument, this time is ripe for making a decision and forestalling it further would only attract further criticism. Any decision taken at the end of 40 years of a particular project will be criticised, whether right or wrong. Following the roadmap above, the outcomes are likely favourable or not, but not taking a decision would only mean failure on all accounts. To the credit of the present dispensation, they have never feared taking a decision. In the case of India's indigenous jet engine development, it is a watershed moment in history, if ever there was one.

Notes:

[1] Samir V Kamat, "Special Address: 21st Subroto Mukerjee Seminar", YouTube 3:00-3:20, January 07, 2025, https://www.youtube.com/watch?v=Ti6oMHp21TE&t=5s. Accessed on January 10, 2025.

[2] Sushant Singh, "Air Force's 16-year wait over, Rafale deal done", *The Indian Express*, September 24, 2016, https://indianexpress.com/article/india/india-news-india/air-force-16-year-wait-over-rafale-jet-deal-done-3046803. Accessed on January 30, 2025.

[3] "Kaveri Engine & Tejas: Powering India's Indigenous Aerospace", *Defence XP*, https://www.defencexp.com/kaveri-engine-tejas-powering-indias-indigenous-aerospace/-. Accessed on January 30, 2025.

[4] "Why India's R&D Dreams Are Falling Behind: Funding Aside, Here's A Look inside the System", *Swarajya*, https://swarajyamag.com/science/why-indias-rd-dreams-are-falling-behind-funding-aside-heres-a-look-inside-the-system. Accessed on January 30, 2025.

[5] AP Singh, "Inaugural Address: 21st Subroto Mukerjee Seminar", YouTube 9:00-9:10, January 07, 2025, https://www.youtube.com/watch?v=P-yLiabiahk. Accessed on January 30, 2025.

[6] Shubhangi Palve, "Project Kaveri and India's indigenous jet engine ambitions may remain in the cupboard", *The Economic Times*, July 13, 2023, https://www.cuts-global.org/article-project-kaveri-and-indias-indigenous-jet-engine-ambitions-may-remain-in-the-cupboard.htm. Accessed on January 30, 2025.

[7] "Defence Ministry Signs Rs 26,000 Crore Deal For Engines For Su-30MKI Jets", NDTV, September 09, 2024, https://www.ndtv.com/india-news/defence-ministry-signs-rs-26-000-crore-deal-for-engines-for-su-30mki-jets-6527343#:~:text=News%20India%20News%20Defence%20Ministry,crore%2C%20an%20official%20readout%20said. Accessed on January 30, 2025.

[8] Ajai Shukla, "India to buy Rs 150,000 cr worth of aero engines in a decade: MoD focus on engine technology", *BROADSWORD*, February 21, 2023, https://www.ajaishukla.com/2023/02/india-to-buy-rs-150000-cr-worth-of-aero.html. Accessed on January 30, 2025.

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