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ISSUE BRIEF

INDUSTRY-ACADEMIA COLLABORATION TO PROMOTE DEFENCE INNOVATION: ISSUES & CHALLENGES

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Abstract

The sub-optimality of resource exchange between industry and academia, as rightly pointed out in the theme "CMF in defence," emphasizes the need for inter-agency harmonization to achieve outcomes greater than the sum of their parts. This paper aims to propose such a framework, which will elaborate on the early difficulties, various stages of collaborative engagement, end-result agreements, and assumptions at each stage, financial challenges, IPR issues, and manpower sharing. Furthermore, this paper will highlight the expectations from both sides and what needs to be taken care of to keep expectations aligned at each stage. Quality, standard, timeliness, security concerns, and achievements of some engagements have also been elaborated upon. The paper concludes by generalizing the variety of issues faced, solutions provided, and how such engagements yield growth for organizations involved in particular and society in general.

Introduction

Academic and research partnerships focused on military objectives are crucial for achieving a qualitative aggregation of capabilities. India's neighbouring countries are already using their academic institutions to gather knowledge and intelligence to advance their strategic goals [1]. India, too, needs Civil-Military Fusion (CMF) between industry and academia for inter-agency harmonization. Currently, resource exchange between industry and academia in India is at a sub-optimal level, with academic research often not related to defence [2]. The Government of India has acknowledged

the need for CMF, as evidenced by a statement made during the Budget session in parliament on February 1st, 2023 [3]: "To unleash innovation and research by startups and academia, a National Data Governance Policy will be brought out. This will enable access to anonymized data." - Smt. Nirmala Sitharaman, Honourable Finance Minister, GOI.

The industry has been rapidly advancing in terms of technology. What was in high demand yesterday is now outdated, and today's technology will also inevitably become obsolete in the future [4]. Many industries focus primarily on delivering their products or services, and then prioritize research in relevant fields. The defence industry has a unique need to continuously learn and adapt to new technologies by leveraging cutting-edge R&D work and infrastructure available in the country's R&D institutions. Academic institutes require infrastructure, live problem sets, scaling of prototype/test bed solutions for research, and working on new technologies. To bridge this gap, academia looks for agencies that can satisfy these requirements.

A program needs to be designed to instil, create, and grow a culture of collaboration between education institutes, domain experts, and industry leaders, driven by an Industry Cell at academia and an Academic Cell at Industry. It is necessary to connect more and more educational institutes as it grows and creates a collaborative growth space. Nature, in the form of Redwood forest, teaches us that our real strength lies in coming together, caring for and supporting each other, and allowing everyone to grow [5], emphasizing 'In Giving We Receive’.

From this perspective, academia and industry seem to be fulfilling each other's needs, creating a win-win situation. As the nature of work is exploratory, it is quite feasible to fail in terms of required outcomes, and results are unknown. Therefore, it is wiser to clarify the conditions of engagement from the start to the end, in terms of deliveries, IPR rights, time-frame, funds, manpower engagement, payment stages, etc., from both entities.

From our experience in handling such engagements, we have prepared the problems faced, lessons learned, and what to do to avoid conflict and match expectations of the involved entities. These details are provided in the following sections from start stage to end stage. One underlying assumption in each of the following sections is that whatever has been stated is exploratory and experience-based and does not act as binding statements.

Defining Problems At Hand

The organizations often undertake numerous projects with competent teams. These projects may require specialized technologies, research expertise, and high-performance requirements, which the organization may lack due to the absence of required experience, trained manpower, or time. In the current era of advanced technology, customers/users demand solutions that leverage cutting-edge features. It is crucial to understand that organizations can switch their business domains to

achieve their goals and targets [6]. However, the technical expertise required in the new business domain may not be available within the organization, leading to technology gaps that need to be bridged. The solution to such requirements is not readily available within the organization, and collaborations with external entities need to be explored.

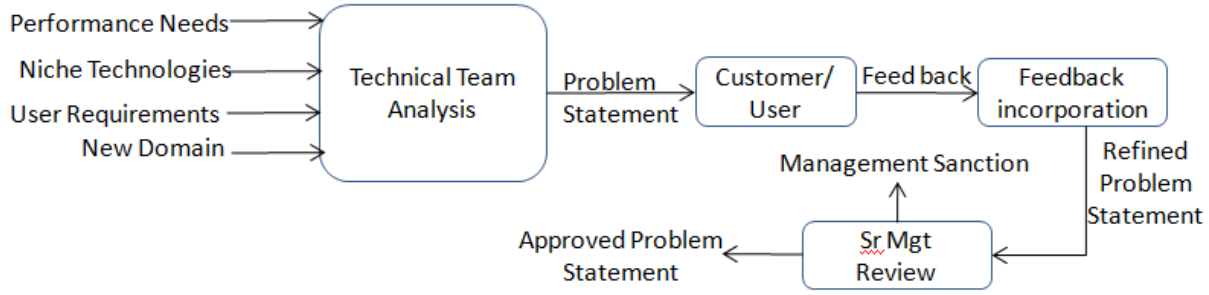

Fig 1: Defining Problem

Academia is a preferred option for collaborative work compared to startups or other organizations due to the expertise available across a large set of emerging technologies. However, before approaching academia, the organization needs to define the problem statement(s), underlying assumptions, acceptable solutions, target system (hardware and software) for interfacing and integration, and performance requirements as crisply as possible. The acceptable outputs, including format and development environment (software and hardware), also need to be defined and converged in a Statement of Work (SoW) document. The SoW needs to be shared and discussed with the customer/user to ensure that everyone is on the same page. However, defining explorative requirements crisply has its own challenges, and customers may not have a complete visualization of the requirements. They may want to add/update requirements during the development process, and some requirements may depend on the results of other requirements. Therefore, it is essential to continuously communicate with the customer/user and update the SoW accordingly.

Finding The Suitable Collaborative Partners

To search for collaborative partners in academia, there are several options available. One of the easiest ways is to refer to the list of top institutes provided by MHRD or survey agencies, which can be easily found on the internet. Another way is to visit the websites of various academic institutions and explore their projects, areas of expertise, and interests. Some professors may directly entertain collaboration requests, while some institutes may have a specific cell for industrial engagements. Academia can also be contacted to inquire about their activities of interest. Planning a visit to academia can also help in better understanding their capabilities and having a demonstration of their work.

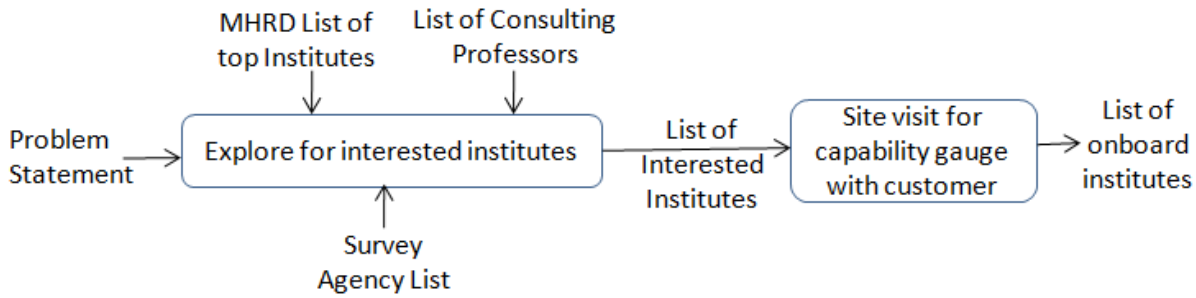

Fig 2: Finding Suitable Collaborative Partner

It is important for both academia and the customer/user to be open and transparent in their communication and expectations. One way to mitigate the risk of misaligned expectations is to have a clear and detailed Statement of Work (SoW) document, as discussed earlier. The SoW should outline the scope of work, project goals, deliverables, timelines, and other terms and conditions. Both parties should review and agree to the SoW before starting the project. It is also important to have a clear understanding of the mode of engagement, whether it is a long-term or short-term collaboration, and the stages of engagement. This can help in planning and allocating resources and ensuring that both parties are committed to the project.

In case of apprehensions about the success of the engagement, it may be helpful to have a pilot or proof-of-concept phase before committing to a full-scale project. This can help in identifying any issues early on and making necessary adjustments. Finally, it is important to have a flexible approach to the scope of work. While it is necessary to have a clear definition of the project goals and deliverables, it may be beneficial to allow for changes in the scope based on the results and observations during the course of development. This can help in ensuring that the project stays aligned with the evolving requirements and expectations of the customer/user.

Preparing Collaboration / Engagement Documentation

Procurement procedures established by the organization may not always be suitable for engaging with academia due to the unique nature of academic collaborations. These procedures are typically designed for dealing with vendors and may not fully account for the nuances of academic partnerships. As a result, there may be some challenges in establishing a legal framework for collaborative engagement with academia.

One option is to create a separate set of procedures for engaging with academic partners. This could involve working with legal and procurement teams to identify the specific requirements and constraints of academic collaborations and developing a set of procedures that are tailored to these needs. This could include provisions for intellectual property rights, confidentiality agreements, and payment structures that are unique to academic collaborations.

Another option is to work with the academic partner to develop a customized agreement that addresses the specific needs of the collaboration. This could involve

working with the academic partner's legal team to develop a contract that meets the requirements of both parties and ensures that the collaboration is legally binding and enforceable.

Regardless of the approach, it is important to establish a clear legal framework for the collaboration to ensure that both parties are protected and that the collaboration can move forward with confidence.

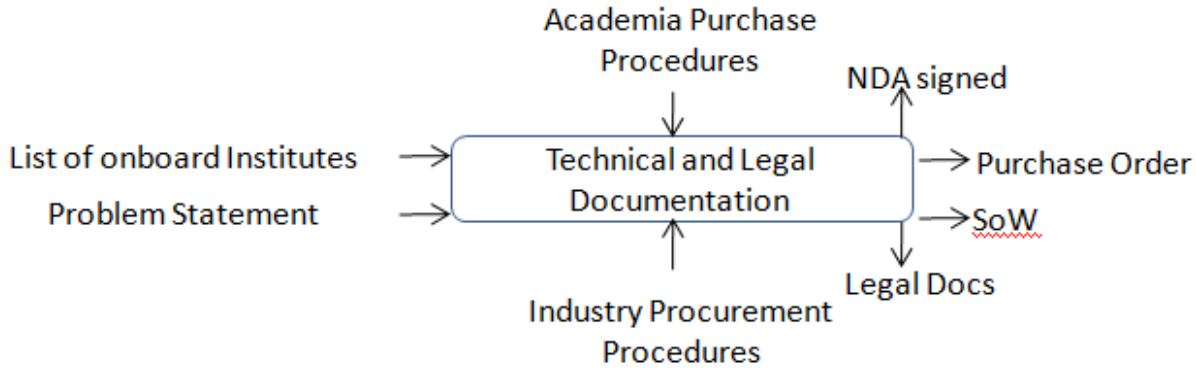

Fig 3: Preparing Collaboration/ Engagement Documentation

Organizations need to agree on a Non-Disclosure Agreement (NDA) and an End Result Agreement with collaborative partners. An Intellectual Property Rights (IPR) sharing mechanism also needs to be established between the organization and collaborating academia, with a mechanism for publications and patents. Joint IPR with a joint review mechanism for publications and patent filing works best in most cases. The financial implication of such outputs should also be contracted. The percentage of payment for every milestone may be aligned to the phases of Collaborative Development Life Cycle (CDLC) as depicted in Fig 6. When a phase is complete, the organization is required to guide academia for raising an invoice for the completed phase. Communication gaps in this process can result in financial concerns, including issues in claiming exemption of GST for R&D activities.

Academia is mostly engaged in research work and does not like to be treated as supplier of some services; rather wants to be engaged as collaborators working hand-in-hand to achieve a common objective. An engagement model for collaborating with academia is described below, which can act as reference and can be customized as per need.

Requirement Understanding And Execution

It is important to take into account the academic calendar and course cycle when collaborating with academia, as they hire staff and students for the required work. Usually, professors act as Principal Investigators (PIs) and recruit students for higher education courses who can work on the project as Research Associates under their guidance. This team, led by the professor, has a fixed tenure. However, there may be instances where the hired student may leave the project before the end of their tenure. Additionally, the hiring process itself may sometimes take a long time. It is important to anticipate and manage these challenges as per the situation.

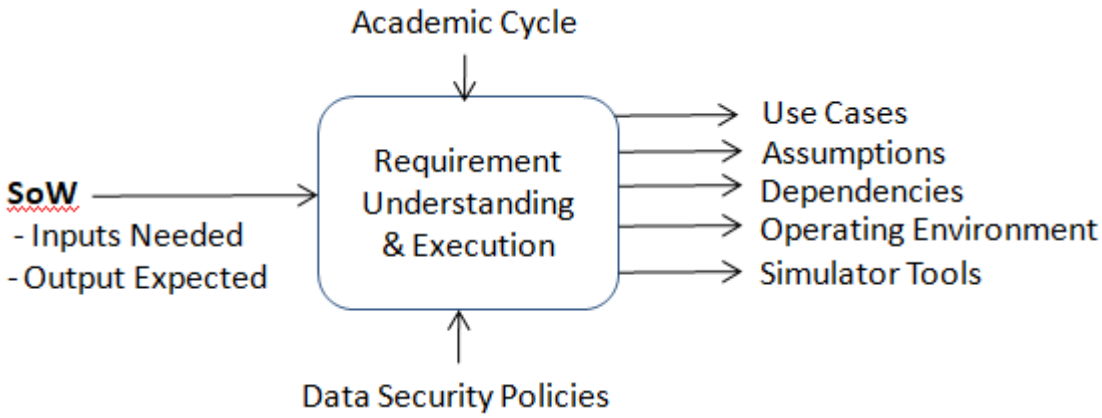

Fig 4: Requirement Understanding and Execution

The SoW specifies the requirements from the organization's perspective. Explicitly detailing all assumptions and dependencies will make it easier for academia to understand the requirements from the same perspective. Visual depiction of requirements with use cases, graphics, tables, graphs, etc., should be freely done along with textual descriptions to allow academia to dive deep into requirement scenarios and be able to "visualize" the SoW. It is also strongly recommended to describe the input data provided/needed, output expected, mode of data sharing, data security aspects in data handling, simulator, tools, platform for development, and operating environment in which the intended solution shall run. The academia should also be explained the tactics behind requirements, operating environment including site visits, pressing need of SoW, solution deployment scenario, and how the solution is going to be useful and a game changer for the customer/end-user. Such processes help in bringing out assumptions, confusions, misunderstandings and resolving those leads to synchronization in requirement understanding.

Academic institutes often require hand-holding from the organization in carrying out development activities as they are unlikely to create products readily consumable by a production environment. Academia mostly gets projects done through students in Masters/PhD programs, under the guidance of professors. These courses have fixed time duration as well as start and end dates. Adherence to the institute's course cycle is required because students working on the project move out of the scope of the institute after courses are over. Consensus is also required for methods to share data during development, keeping in mind compliance with security guidelines, quality control of the deliverables, and compliance with standards during development, which is a challenging process. Usually, institutes work on advance payments, needed to initiate project setup and recruit students. Therefore, organizations need to support the institutes financially as per the institute's needs by ensuring that its procurement procedures have provisions for advance payments for academia.

ToT & Support

The team from the organization should work closely with academia right from the start of the engagement. The team should be trained to fill any technology gaps that may be required during the absorption of the solution, with the training being provided by either

academia or the organization. The solution provided by academia may consist of pseudo codes, algorithms, and design sheets that may not be in a readily integrate-able state and may not comply with industry standards. Therefore, the team should be capable of understanding the solution provided by academia. Once the training is complete, the team should be ready to absorb the intended knowledge and put it to use for future products.

During Transfer of Technology (ToT), expectation mismatches are common and can lead to technical disagreements and payment-related issues. These issues can be avoided or minimized if the team ensures that expectations are aligned from the very beginning and that all issues are put on the table regularly. If left unattended, these issues may hamper the prospects of long-term engagements.

Fig 5: Requirement Understanding and Execution

The team should act as bridge to provide necessary inputs to academia from time-to-time so that solution being developed remains aligned to the organizational requirements. Concerns and issues of both academia as well as organization should be frequently discussed and resolved. Meetings should be conducted with relevant stakeholders to, align and be on same page.

After the ToT is complete, the team should integrate the academia-provided solution unaided. Support from academia will only be to clarify issues or queries in the already provided solution and not to work further towards integration.

Collaborative Development Life Cycle (CDLC)

The model consists of four phases of development, called milestones, as detailed below:

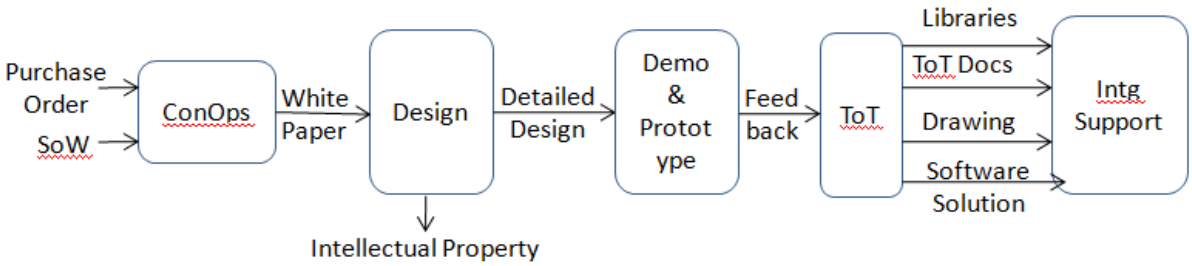

Fig 6: CDLC Model

Phase 1: ConOps

Academia shall provide white paper bringing out possible ways to achieve the desired functionality. The contents of white paper shall include (but not limited to):

(a) Problem Refinement: Detailed explanation on underlying concept.

(b) Final I/O alongwith format
(c) Platform Finalization
    (i) Software (language, Operating System, any other application)
    (ii) Hardware needed (if any)
(d) Finalized Solution Approach
(e) Dependencies
(f) Documentation:
    (i) What part of solution is readily available and what part of solution need to be worked upon.
    (ii) How ToT will be done

Phase 2: Design

After the initial stage, detailed design is prepared, explaining design options considered, analysis of the options, algorithms to be used, bringing out a detailed design document.

Phase 3: Demonstration & Prototype

After the solution developed by academia is close to completion, the demonstration of the same shall be shown at academia, alongwith prototype of model, if required. Demonstration shall include (but not limited to):

a. Architecture
b. Prototype

Phase 4: ToT

After demonstration, handover process to organization shall start at organization premises. This will involve ToT, with physical present of academia. By the end of ToT, academia shall be handing over the technology solution to organization. ToT Deliverables shall include (but not limited to):

a. Packaging Libraries
b. Fully functional software (along-with source code)/ solution/ algorithm (as the case may be)
c. ToT Documents

Phase 5: Integration Support

During Integration/ Field Acceptance Test, support by academia shall be provided through phone, e-mail or physical presence, depending on the need.
Once the CDLC is complete and outputs are accepted / recorded, the collaboration can move to closure activities.

Closure & Way ahead

When academia has finished its intended tasks, organization should be ready to absorb the solution, technologies and get itself into the shoes of owner of the

developed solution. This will also be the time, to analyze with matured understanding, whether residual gaps were there in initial SoW. If so, further engagement may be required and new SoW may need to be prepared as extension or splinter.

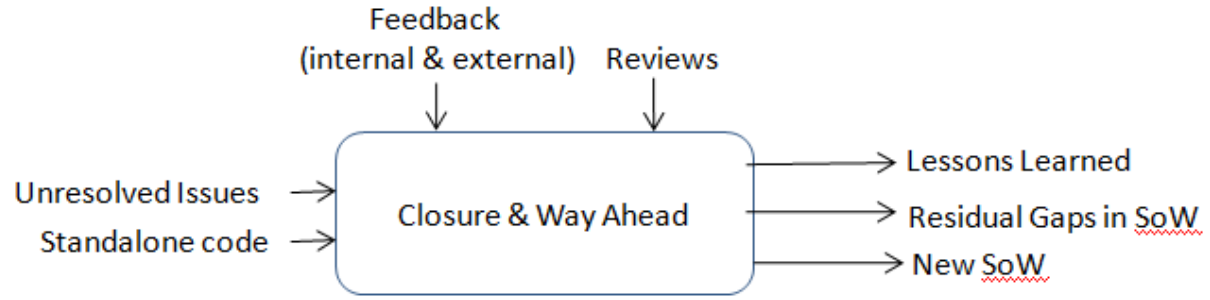

Fig 7: Closure & Way-ahead

Summary & Recommendations

The paper has covered most of the issues and challenges which might arise during each phase. The table summarizes the phase-wise key issues / and challenges along with authors' recommendations:

S. N.	Phase	Key Issue / Challenge & Recommendation
1	Defining problem at hand	Development agencies and defence users must come to an agreement regarding what is feasible within the project scope and timeline, while ensuring that the solution will benefit the defence forces during actual operations. To determine feasibility, defence industries must stay informed about the latest advancements in the academic world related to any identified gaps. It is crucial to have a mechanism in place to access available academic resources. Additionally, PG programs/certifications for defence forces' users/customers and reserved academic seats for defence personnel can aid in their development and enablement.
2	Finding the suitable collaborative partners	Central agencies should frequently publish a list of collaborative partners, along with their areas of expertise, so that partners matching the work statements can be easily found. Additionally, academia should be introduced to operations oversights of the tri-services through visits and participation in exercises at places such as INTEG, ARTRAC, SDD, AD Operational Nodes, and the defence Wargaming setups.
3	Preparing collaboration/ Engagement Documentation	To facilitate ease of engagement between industry and academia, an industry cell at academia and an academic cell at industry should be encouraged. Additionally, a mechanism for the direct engagement of students (Master's/PhD) should be put in place for the development of short-term technology modules. To ensure a clear understanding of intellectual property rights (IPR) sharing, a framework should be developed between industry and academia. Furthermore, to simplify operations between industry and academia, a separate set of procedures for engaging with academic

		partners should be established, as academic partners cannot be treated as vendors, and L1-based selection criteria cannot be applied to them.
4	Collaborative Development Life Cycle (CDLC) (Requirement, Execution, ToT)	To develop acceptable solutions for defence applications, ample data, data references, rules, and business logic should be provided to academia. Execution of the project should be in sync with the academic calendar, taking into account the short-term availability of research students. The team responsible for absorbing academic output should be competent enough to convert it into industrial standard applications.
5	Closure & Way Ahead	Development Agencies (DA) should expect academic institutes to be on board until the solution is fielded, and it is in DA's best interest to ensure integration support. Although academic engagement can be a one-time job, it is preferable to have a long-term Memorandum of Understanding (MoU) with general terms and conditions for collaborative engagement and retention, considering that defence projects and the lifetime of defence solutions typically range from 20 to 40 years.

DISCLAIMER

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