Innovate or Die

A guide into the military research ecosystem

by Martin Schüler

Resumé

Syftet med denna artikel är att diskutera hur ett innovativt ekosystem kan skapas för att stödja militär innovation. Krigföring har alltid varit beroende av innovation för att öka soldaternas dödlighet, säkerhet och överlevnad. Sverige och Försvarsmakterna kommer sannolikt att ansluta sig till Nato med dess fokus på teknisk innovation. Strategiska dokument som reglerar hur forskning beställs inom Försvarsmakterna har analyserats med hjälp av aktivitetsteori. Resultaten indikerar att flera regler är motsägande och stödjer inte kunskapsförvärv inom okända områden. Systemdesignen för att förvärva kunskap bygger på antagandet om värde, vissa typer av kunskap är mer värdefulla än andra typer av kunskap. Intressant nog bedöms kunskap om militär praktik och militär ledningsfilosofi som meningslös enligt systemdesignen. Denna studie har flera begränsningar, en av dem är tillgängliga dokument som beskriver hur forskning och kunskap ordnas mellan Försvarsmakterna och andra forskningsenheter. En annan begränsning är den militära sökmotorn, som inte verkar visa söksvaret på ett tillgängligt och tillförlitligt sätt. Framtida forskning bör fokusera på interventioner och förändringsledning för att hjälpa Försvarsmakterna att utveckla ett innovativt ekosystem.

Chat GPT has during 2023 received attention and public interest even among soldiers and officers. Large language models are not new,[1] but they haven't been accessible or visible to the public eye. From the launch of Chat GPT 3, news regarding artificial intelligence has been almost everywhere. Simultaneously with launch of Chat GPT 3 the Swedish Armed Forces (SwAF) also released a report on how SwAF should develop military capacities to ensure military relevance in the future:

> During the period, the collaboration program is strengthened to achieve increased cooperation with civilian financiers and performers. An example of such activity is innovation within the field of digitalization.[2]

This sparked a process to involve universities and scientists for the military to gain access to technical knowledge. After an initial failed attempt at military-university cooperation, I came to realise that creating cooperation between SwAF (Swedish Armed Forces) and different universities is an impossible task. Fostered in both cultures, my initial attempt had an academic collegial framework excluding the economic perspective. Cooperation between the military and universities is almost always equal to the transfer of money, a task that proved to be unfamiliar and unnatural for SwAF. Many officers recognized the importance of innovation and technical advances but couldn't commit with financial means.

Introduction

Military innovations have always been a part of warfighting and have had a significant impact on the battlefield with new technologies such as aeroplanes, tanks, and the atomic bomb. The need for innovation in warfighting is undisputed. Both parties struggle to gain an advantage over the other party either by new military tactics or by equipment. During World War II, the development of radio equipment, tanks and rapidly moving units also created a new type of unit which could intercept messages.[3] The ability to read message is arguably a significant advantage.

The Russian invasion of Ukraine has brought war back to Europe, influencing political governance. Sweden is applying for NATO membership which creates a shift in policy making innovation a part of the military strategy.[4] The Swedish government has initiated an innovation initiative.[5]

> Internationally, several different initiatives are underway in defence innovation. NATO has its innovation program called DIANA, to which Sweden can join when it becomes a member, and its NATO Innovation Fund (NIF). Within the EU, there has been a recent decision to increase engagement within the Permanent Structured Cooperation (PESCO), with a focus on innovation and research. However, there is also a need to enhance our national capability to leverage emerging and disruptive technologies in the form of military innovations.[6]

The innovation initiatives are not directly accessible from a military perspective, they demand cooperation between the SwAF, universities, research institutes and the defence industrial sector. Ideas, knowledge and data are commodities which need to be shared among the actors.[7] In some specific domains such as fighter aircraft- and underwater capability and parts of the command and control system, political directives support the process of cooperation and knowledge sharing,[8] but not including artificial intelligence as a whole.

The technological advances in the field of artificial intelligence have gained public and political interest and will likely have a great impact on the labour market.[9] Several articles have been written about artificial intelligence as a new tool[10] in different functions and domains. Artificial intelligence will likely impact military work in ways we can't phantom. The need for continuous innovation in the artificial intelligence field and the military work practices for increased lethality is not mind-boggling or far-fetched. The need for continuous innovation causes a window of opportunity for something else, an ecosystem for innovation with other actors.

Stanford model

Innovate or die[11] seems true in both business[12] and warfighting.[13] Innovation initiatives have been supported in other countries such as the United States of America. One well-known example of innovation is the Stanford model which has generated numerous start-up companies making products out of ideas. The success of the Stanford model lies not in a single factor but in several factors and unplanned circumstances. The military need for technology and advanced communications for military operations became the backbone of today's Silicon Valley, large government contracts helped early high-tech companies to stabilise.[14] During World War II the Palo Alto region experienced a rapid increase in its labour force and companies transformed their civilian production to war production.

Stanford received government funding to develop electronic components.[15] The mak-

ing of Stanford's unique start-up culture as an innovation hub in the Western United States started after World War II. Frederick Terman became a key figure when returning to Stanford after completing a defence project, developing radar countermeasures. The project's success contributed to a change in the government research strategy to involve universities in defence research. Early on Terman inspired two students to start a company, Hewlett-Packard which became the foundation of today's Silicon Valley.[16] Several attempts have been made to replicate the interactions using Stanford and Silicon Valley as a role model when creating new ecosystems for innovation.[17]

Understanding the prerequisites for a defence ecosystem for innovation

The innovation ecosystem originates from business ecosystems and how businesses evolve. The metaphor predator and prey was previously used to describe the mechanics behind evolving business ecosystems concerning evolving species.[18] In the wild,

> Dominant combinations of species may lose their leadership. New ecosystems then establish themselves, often with previously marginal plants and animals at the centre.[19]

Historically in Sweden, the defence community as a whole has been the predator and universities have been the prey in a system that could be compared to a business ecosystem which captures value.[20] Technological advances have flipped the table and created a knowledge deficit. Likely military development in Sweden will face two possible outcomes: (1) accepting a new role as prey, (2) changing how knowledge is transferred and how a project is created and financed. Accepting the role as a prey could also transfer how projects are created to foreign companies which could create strategic implications when new technology is implemented in the SwAF. Changing how knowledge is transferred and how projects are created and financed would imply a military ecosystem for innovation creating value.[21]

One definition of an ecosystem for innovation is,

> An innovation ecosystem is the evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.[22]

The key to success is the mutual evolution. What drives the military is the need to defend against or attack an opponent, not a sellable product. Need-driven ecosystems focus on technological or environmental change experienced by the end user.[23] The purpose of this article is to discuss how an innovative ecosystem can be created to support military innovation.

Method

Documents from the SwAF website were collected using the public military search engine. The documents are classified as open and accessible to the public.[24] Activity theory (AT) was used as an analytical lens to penetrate the material. AT has been used to conceptualize how ecosystems work.[25] Innovative ecosystems are driven by a need to develop new products. Financial means can be seen as rules or guidelines for product development.[26] To understand how different incentives can be used to stimulate innovative activity and human behaviour activity theory (AT) was used as a design

tool to get a deeper understanding[27] of the military research field,

> Designers tend to use it in the early phase of a project to help framing the problem and to gain a deeper understanding of the issues that need to be worked on.[28]

Swedish defence research

Sweden has several universities from north to south with various specialities. Most universities in Sweden seek cooperation between business life and academia, resulting in hubs or centres inspired by the Stanford model.[29] In most cases, the defence community is not present. The Swedish defence research system consists of four main actors: (1) SwAF, (2) The Swedish Defence Research Agency (FOI), (3) The Swedish Defence University (FHS), (4) The Swedish Defence Materiel Administration (FMV). The military research project is derived from SwAF military needs. The needs are discussed between the actors and formalized in an annual order to FOI, FHS, and FMV. In some cases, SwAF uses other actors (universities and foundations) to answer specific research questions. The means of financing research is mainly through military funding, and in exceptional cases also the European Defence Fund (EDF).

> The Fund finances up to 100% of the total eligible costs of awarded projects, in particular through grants, including up to 35% of possible bonuses. Research activities could be funded up to 100% while development activities have different funding rates complementing Member States' or industrial investments, between 20%-80% from prototyping to certification.[30]

The design of the financial model for military research and development is mainly focused on distributing Swedish military funding to known actors in the defence community. This causes a lack of interest in other types of financial means accessible only through academic partners such as EDF.

Activity theory as a design tool for innovation

AT has its roots in Vygotsky's theory of the mediating artefact.[31] Leont'ev develop the original triangle *(Subject – Mediating Artefact - object)* by changing the name of the *Mediating artefact* to *Tools* and adding a new base to the triangle with three new categories *(Rules, Community, Division of Labour)* Leont'ev created the first generation of AT focusing on individual behaviour.[32] Engeström developed AT further by applying AT to understand collective behaviour thus creating the second generation of AT (see Figure 1).[33] The third generation of AT consists of two or more interacting activity systems creating a shared object.[34]

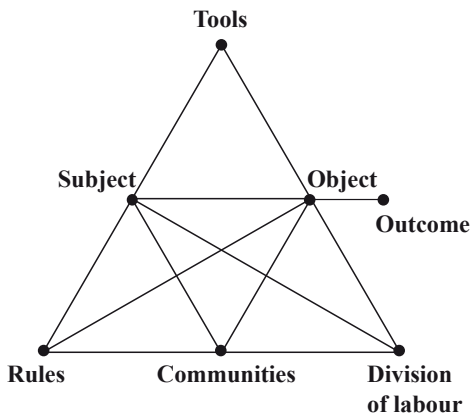

Figure 1. The second generation of activity theory.

AT consists of seven categories: (1) *Object* is the problem the work is addressed towards and has a specific (2) *Outcome*, (3) *Subject* consists of the individuals performing the activity, (4) *Tools* are used by the individuals when performing the activity such as

knowledge, experience, and equipment, (5) *Rules* can be explicit such as laws, regulations, instructions, handbook regulations, and work tasks or implicit such as workers collective perception how a specific work task should be performed, (6) Several groups can contribute in different ways to the creation of the *Object* and are organized under *Community*, (7) *Division of labour* emphasizes how tasks are divided and how the power is distributed.[35] The *Object* is the sense-maker of the activity system shaping the categories within the activity system.[36]

Data preparation

The document was imported into NVivo and analysed. The NVivo text search function was used to identify appropriate information in the documents. The words innovation, research, development, EDF, and DIANA were used for text searches. Text including the words was added to a NVivo case for each document. The cases were then coded using the seven categories in AT (see Table 1). The categories were then analysed for additional topics.

Table 1. Codes from the strategic document

Categories	1[a]	2	3	4	5
Outcome	0	0	0	2	0
Tools	0	1	0	2	1
Rules	0	3	5	7	4
Community	0	0	0	2	0
Division of labour	0	0	0	3	0

Not: The SwAF Military strategic doctrine 22 contained no information regarding research, innovation, or development. 1 (Military strategic doctrine, 2022), 2 (The perspective study 22), 3 (Swedish Armed Forces Strategic Direction 2021-2030), 4 (Swedish Armed Forces budget for 2024), 5 (Swedish Armed Forces revised budget for 2024).[37]

Results

From the data analysis with AT the desired *Outcome* of the research procurement is an increased military capability in already known and developed areas, "By building and maintaining competence for SwAF's needs".[38] Building and maintaining indicates that the SwAF has a perception of what is needed to fight and win over an opponent. To regulate the research procurement several *Rules*, direct the research activity. *Rules* covering four areas were identified: 1) civilian research, 2) perception of research, 3) research collaboration, and 4) military capability.

Examples of *Rules:*

1. Civilian research; *Technology development for the needs of military defence is increasingly being driven by non-military organizations and companies.*[39]
2. Perception of research; *The SwAF, therefore, propose further investments in national research and development within the defence area, as well as in coordinating research and development with civilian and international actors, both financiers and executors.*[40]
3. Research collaboration; *Several areas of technology are operated in civilian contexts and there is an increasing need for collaboration with these environments in order to utilize knowledge in defence.*[41]

4. Military capability; *Research and technology development activities that bring knowledge closer to utilization in military operational capability must be strengthened.*[42]

SwAF has a clear ambition to incorporate and integrate research from universities into the military domain especially research with a practical focus. Financial means seem to be the only available *Tool* to create research. From the accessible documentation on the SwAF webpage, there are references to both the European EDF and NATO DIANA for research funding.

> In connection with NATO membership, additional opportunities are given to contribute to the development of the alliance, regarding concept development as well as innovation and research. Especially within the innovation initiative DIANA, there are increasing opportunities for Swedish actors within the alliance.[43]

There are other financial means accessible for funding research and development: (i) internal military means, (ii) external means for military research and development such as EDF, NATO Defence Innovation Accelerator for the North Atlantic (DIANA) and NATO Innovation Fund (NIF), (iii) external means for social security, innovation, and technology development such as EU Horizon, (iv) external corporate investments in research and development.

From the coding of the data material two interacting activity system emerge, military and civilian research (see Figure 2),

> The Swedish Armed Forces believe that military and civilian research should be seen as complementary activities and that a holistic research approach is required.[44]

The main effort of guidelines is to co-create an object to support the development of military capability,

> Several areas of technology are operated in civilian contexts and there is an increasing need for collaboration with these environments to utilize knowledge in defence.[45]

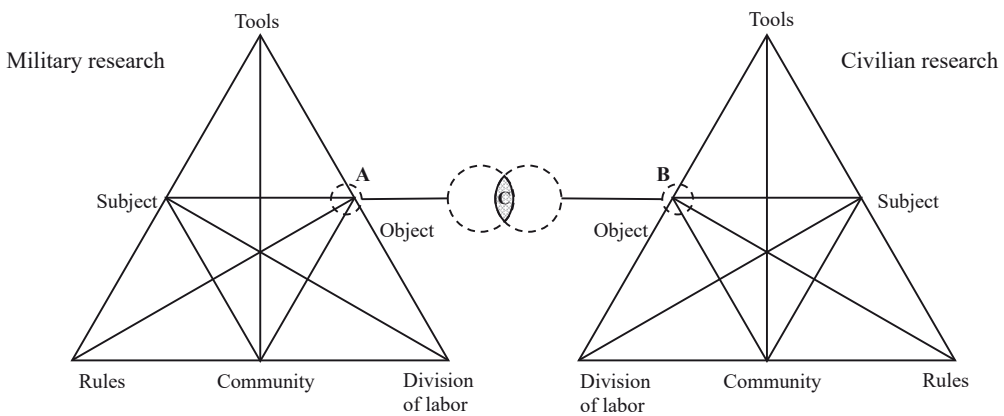

Figure 2. The third generation of activity theory: military, and civilian research. The Object (A, results from military research) should interact with Object (B, results from military research) creating or updating the document (C) with military capability.

Discussion

The purpose of this article is to discuss how an innovative ecosystem can be created to support military innovation. The results from analysing the strategic document regarding research and development show no similarities with the ecological view of innovative ecosystems. Instead of the evolving actor,[46] SwAF is trying to regulate and constrain civilian research actors with boundaries separating SwAF from those performing the research. What could be interpreted as a predatory business ecosystem.[47] From an AT perspective, this is best described as two activity systems creating a shared object.[48]

The shared object creates several contradictions between military and civilian research. Does military research exist or is it only a classification to uphold traditional values and ways of financing research? Another contradiction lies within the perception of knowledge where research should mainly be focused on developing what we already know not on what we don't know. The *Rules* generated by the military organization are designed to steer external organizational behaviour, not practices. The co-creation of the shared object likely creates a shared agency. Shared transformative agency is when a group of individuals searches collaboratively for a new form of meaning to perform the activity they are engaged in.[49] Based on the design of the *Rules* implemented to guide civilian research they could have a contradicting effect and drive research away from the military domain towards what is best for the university or the researches conducting the research.

The results indicate a system designed for ordering research in known areas not exploring the unknown--more of the same, mainly technical or scientific knowledge. The fundamental contradiction lies not in the categories of AT but in the fundamental knowledge philosophy and what value different types of knowledge have. Logical positivism emphasises scientific knowledge as the only dependable knowledge.[50] Logical positivism judges knowledge as meaningful, meaningless or tautological, "physical sciences are regarded by logical positivists as being meaningful statements".[51]

From a military perspective, social science seems to be judged as meaningless. Notable is also the contradiction between the system of acquiring knowledge and the military philosophy of mission command with its ontological roots in practical knowledge:[52] military personnel create solutions to military problems with their knowledge, skill and wisdom by learning from historical events without being affected by the dialectics of history. To gain a more innovative outcome of invested money an alternative would be to implement a more practice-oriented design with a philosophy which embraces the military practice such as pragmatism.[53]

There is no evidence to support any effort of creating an innovative ecosystem.[54] Much like Stanford and Silicon Valley stable government funding exists,[55] but with constraining *Rules* and without the ambition of generating start-up companies or evolving actors a fundamental function in the ecosystem design.[56] The Swedish military strategic doctrine contains no mention of innovation which stands in stark contrast to the NATO strategic concept with its link to innovation. Developing knowledge in technical areas and areas affected by technology is important for any competitive military force.[57]

This study has several limitations, one being, accessible documents describing how research and knowledge are ordered between SwAF and other research entities. Another limitation is the military search engine which doesn't seem to display the search answer

in an accessible manner. Other documents probably exist which haven't been located. Despite the study's limitations the results still offer some thought-provoking results.

Future research

Based on the principles of innovative ecosystems and need-driven ecosystems future research should focus on interventions and change management. Change laboratory could perhaps be a useful tool[58] when developing a more open system design where all financial means are included. A modest suggestion would perhaps be to include how research is financed and how research is conducted at universities in Sweden when designing such a system. Different actors work at different levels of the defence research system (see Figure 3). The lower part of the model (actor economy) illustrates what type of financial means different actors mainly have access to. The upper part of the model (project economy) illustrates how financial means can be used to stimulate research activity for a specific project application.

The letters X, Y and Z represent three different research activities. The letter (W) is a composition of two research activities (Z and X). Internal military means (i) are used to stimulate a research activity which hopefully answers the research question (secondary outcome) but can also be used to create other research applications (primary outcome). The military commitment can stimulate the creation of a research application for projects financed with external financial means (ii and iii). A consequence of attaining a project with external means is the corporate attraction which could lead to additional projects financed in part by the defence industry.

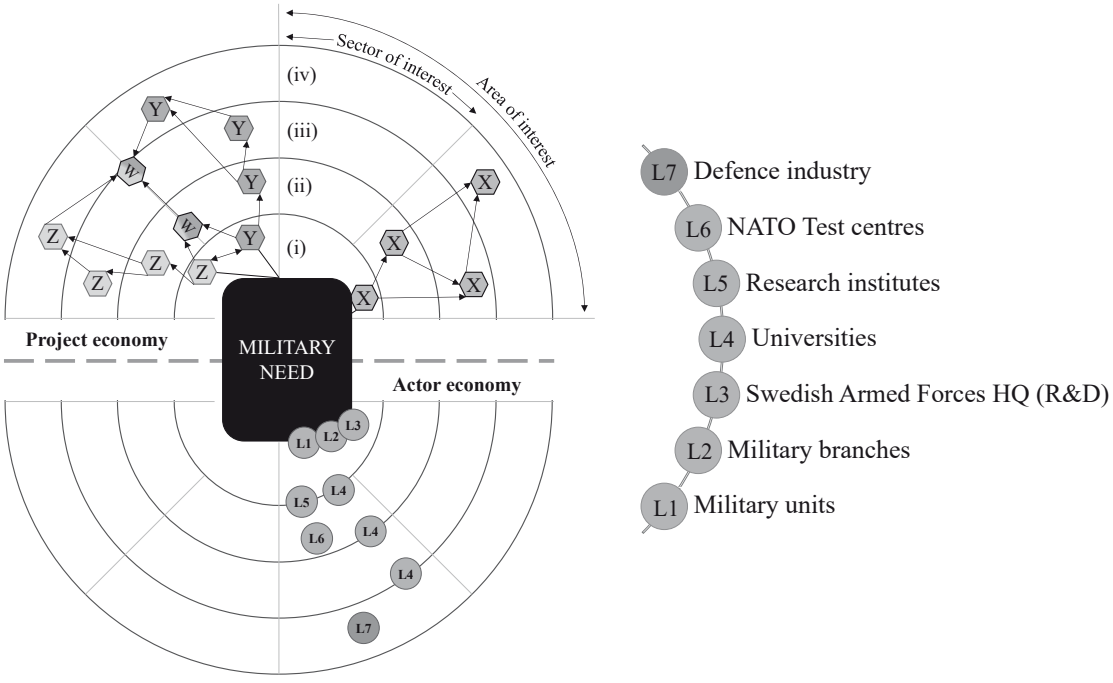

Figure 3. The dual model of actor and project economy and project outcome interactions.

Tentative activity framework for an ecosystem

Subject

Consists of researchers with an interest in developing or understanding technology for military use.

Object

The document research application.

Outcome

Research projects financed with external means with a practical application for military use contributing to the military activity of defending or attacking an opponent. The project results can be used to co-develop products increasing military capability.

Rules

Security agreement regarding military data sharing between SwAF and the scientific community. Research results must have a practical application with concrete product development and production as an end state. Clear guidelines state that project members are required to seek external project finances on their own to generate project revenue. Over three years, the military investment should be matched with a minimum of three to four times the amount of external finance. Project financial audit every three years with clear consequences, failure to meet the requirement results in a warning, fail to meet the requirement a second-time results in project termination. Project members that participate in failed projects can't be part of new project applications for two years (financial quarantine).

Tools

Use political engagement in designing strategic research topics as a tool to increase university commitment. Use military research funding as a strategic tool to guide and steer the attention of researchers. Use the formation of Swedish NATO test centres as a tool to stimulate university and institute engagement in specific fields such as artificial intelligence, robotics, space, underwater technology, and aviation. Create doctoral student projects which can be used to create collaboration and practical knowledge between universities and the military. Co-create a gateway between the scientific community and the military which can coordinate research opportunities and military needs. The military is a hierarchal and rigid organisation with internal bureaucracy--a hub or a centre for defence innovation could help in increasing accessibility for universities, institutes, and the military. Stimulate officers who have appropriate academic knowledge to participate in research projects to increase the practitioner network. Use conferences, incubators, and hubs to communicate with universities, institutes, and different corporations.

Community

Technology universities and universities with a socio-technical profile, research institutes, defence corporations, NATO, EU, Swedish government agencies, NATO test centres, military research and development officers, military schools, and conferences are all part of the community.

Division of labour

Using military research funding and creating NATO test centres to stimulate research in specific fields using specific universities could be a form of division of labour.

Conclusion

The system design of acquiring knowledge is based on the assumption of value, while certain types of knowledge are worth more than other types of knowledge. Interestingly, knowledge about the military work practice and the military command and control philosophy is, by the system design, judged as meaningless.

The author is major, holds a PhD and serves at the Swedish National Defence College.

Notes

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