WASP | WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

WASP 2030

Paving the Way

Contents

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Foreword

In 2014 Knut and Alice Wallenberg Foundation (KAW) invested in a comprehensive research program in the areas of autonomous systems and software with the primary objective of conducting excellent research and building competences for the benefit of Swedish industry. The program Wallenberg Autonomous systems and Software Program (WASP) was launched 2015 with an initial budget of 1.8 billion SEK over 10 years, the majority of the financing is from KAW with an additional co-funding from WASP partner universities and by Swedish Industry.

By November 2017 the program was further expanded with additional funding of 1.0 BSEK for research in artificial intelligence (AI). The research in artificial intelligence also includes the mathematical foundations of AI. As a consequence the initiative was changed to Wallenberg AI, Autonomous Systems and Software Program but the acronym WASP continued. The structure of WASP was expanded with "WASP-AI" to incorporate the AI branch and the autonomous systems and software part was named "WASP-AS". Since then, the program has been further increased with an extension to 2026. Still, the objective of excellent research and competence for Swedish Industry has been unchanged.

In September 2019 the WASP International Scientific Advisory Board (ISAB) in its report recognized the progress and success of WASP and has requested a clearly formulated narrative and strategy for the program going forward. Also, in November 2019, WASP was given an added mandate and mission by an additional donation of 1.3 BSEK from KAW and a further extension to continue until 2030. WASP now has a budget of 5.5 billion SEK for 14 years and is by far the largest individual research program ever in Sweden.

The start of year 2020 was also the start of a new leadership in WASP with a new board, a new chair and a change of program director planned for mid 2020. In addition, ISAB has been extended with new members strengthening the competence of ISAB in AI, mathematics and software. The increased funding, mandate and extension of the program, and the request from ISAB, made 2020 an excellent point in time to thoroughly consider what we want to achieve with WASP until 2030 and how. Hence, to reflect these changes, a new narrative and strategy for the program is presented. In this narrative, the vision and the mission of WASP is articulated, as well as our wanted position by 2030 and the instruments that will take us there. For this purpose, initial discussions in WASP management groups and board, started late 2019 to be followed by extensive work in program management groups and board during the first half of 2020. The result was compiled into a report detailing the WASP Narrative, Strategy and Goals. This document is a condensed version of the internal full report focusing on the long-term goals and strategies as well as describing new instruments.

I would very much like to take this opportunity to sincerely thank everyone who has contributed to this document and the underlying work. It has been an extensive effort and I am convinced that this work will be of great value for WASP and "Pave the Way" towards 2030.

Sara Mazur
Chair WASP board of directors

1. Executive Summary

This report briefly describes the current status and future directions for the Wallenberg AI, Autonomous Systems and Software Program (WASP), which is a major national initiative for strategically motivated basic research, education and faculty recruitment in artificial intelligence, autonomous systems and software technology.

To set the arena and path forward for WASP, nine Wanted Positions, describing where Sweden should stand by 2030 in the areas of AI, Autonomous Systems and Software are presented. The positions fall into three main categories:

1. Positions describing ambition of highest possible level of research impact, quality, and strategic coverage, underlining the core values of WASP.
2. Positions reflecting the instrumental role and need for world class level of research environments, graduate training and international collaborations hosted and initiated by WASP.
3. Positions on the fundamental and enabling role WASP plays for Swedish industry and leadership in actions to promote the Swedish position as a leading digital nation.

The current instruments are: **Research Program, Graduate School, Recruitment, Research arenas, Internationalization, Communication events and networking**. In a separate report, a correlation analysis between the wanted positions/strategies and the current WASP instruments has been done. These WASP instruments are shown to be well positioned and contribute to multiple wanted positions. Still, there is motivation and potential for new instruments for WASP to consider. These proposed new instruments are briefly outlined in this report and include:

- **New Cluster Structure:** Building on the identified core technology areas and applications a new cluster model is defined to increase relevance and function of the clusters of WASP PhD students.
- **WASP NESTs:** Supporting research environments and networks of excellence building on the keywords Novelty, Excellence, Synergy and Team.
- **WARA 2.0:** Identification of the need for systems demonstration and general purpose platforms forms the basis of a refocusing of the WASP research arenas.
- **Career Program:** Providing opportunities to establish research groups for WASP alumni with high academic potential.

The document describes each of these instruments along with their motivations and concludes with an outlook beyond 2030 and the projected continued need for building on the success of WASP and its partners.

2. Vision | Mission | Status

2.1 WASP

The Wallenberg AI, Autonomous Systems and Software Program (WASP) is a major national initiative for strategically motivated basic research, education and faculty recruitment in artificial intelligence, autonomous systems and software development. WASP was initiated in 2015 and its mandate extends to 2030.

The ambition is to advance Sweden into an internationally recognized and leading position in these areas. The starting point for WASP was the combined existing world-leading competence at Sweden's five major ICT universities: Chalmers University of Technology, KTH Royal Institute of Technology, Linköping University, Lund University and Umeå University, and when a large AI expansion was added parts of Örebro University and Uppsala University were included in WASP.

WASP strengthens, expands, and renews the national competence through strategic recruitment, a challenging research program, a national graduate school, and collaboration with industry.

2.2 Vision and Mission

The scope of WASP is artificial intelligence, autonomous systems, and software (AI-AS-S), in the context of complex software-intensive systems with the intelligence to achieve autonomy in interactions with humans. The field is a large and rapidly increasing part of the development of almost all engineering systems. Further, artificial intelligence and autonomous systems are scientifically challenging, disruptive technologies that will fundamentally change society and industry. Swedish industry is, by tradition, strong in systems engineering, and to stay competitive, Sweden needs to invest in research and the promotion of competence in this area.

VISION Excellent research and competence in artificial intelligence, autonomous systems and software for the benefit of Swedish industry.

MISSION Build a world-leading platform for academic research that interacts with leading companies in Sweden to develop knowledge and competence for the future.

2.3 Strategic Instruments

The instruments implemented to achieve the vision and mission are designed to achieve leverage, renewal, and expansion. They have to meet the challenges in research, in building competence, and in strategic relevance. We provide, below, a list of the current instruments.

- **Research Program:** A research program aiming for disruptive developments. This can be seen as a matrix between strategic areas and thematic areas, and several different initiatives have already been devised in the different calls.
- **Graduate School:** A national graduate school in close interaction with Swedish industry with the aim to raise the level of knowledge in Sweden. The graduate school is designed to admit least 600 new PhDs, at least 150 of whom will be industrial PhD students.
- **Recruitment:** An international recruitment program, both to build the competence to establish new research areas and to reinforce existing strengths in Sweden. The program aims to recruit both outstanding younger researchers as well as established experts. This is being achieved by offering packages that are attractive by international standards.
- **Research arenas:** A joint university and industry initiative to share infrastructures and competence and conduct joint in-depth projects and demonstrations based on the resulting advanced platforms. The arenas entail significant integration efforts at the intersection between industrial and academic interests.
- **Internationalization:** Partnership with selected internationally leading universities for PhD student research visits and post-doc program. Current WASP partner universities are Nanyang Technological University, UC Berkeley and Stanford University.
- **Communication, events and networking:** Organization of topical conferences and networking events among existing and potential WASP partners. Coordination of communication targeting internal partners, external industrial, academic and organizational bodies as well as communication to the general public.

2.4 Status and Current Instruments

During the first period of WASP, 2015-2017, the WASP Board formed the organization, initiated the research program and the autonomous systems and software part of the graduate school with both academic and industrial PhD students, completed the first recruitment processes, and initiated the research arenas. The second period 2018-2019 has been marked by a significant build-up of the AI component of WASP. WASP-AI has admitted academic and industrial PhD students into separate tracks of the graduate school, as well as recruiting younger researchers in both machine learning and mathematical foundations of AI. Furthermore, a recruitment program of Wallenberg Chairs, including the Wallenberg Guest Professors, has been implemented. For the recruitment process WASP has developed novel procedures and, in this way, has been a forerunner in the Swedish academic system.

Main highlights of the WASP instruments so far include:

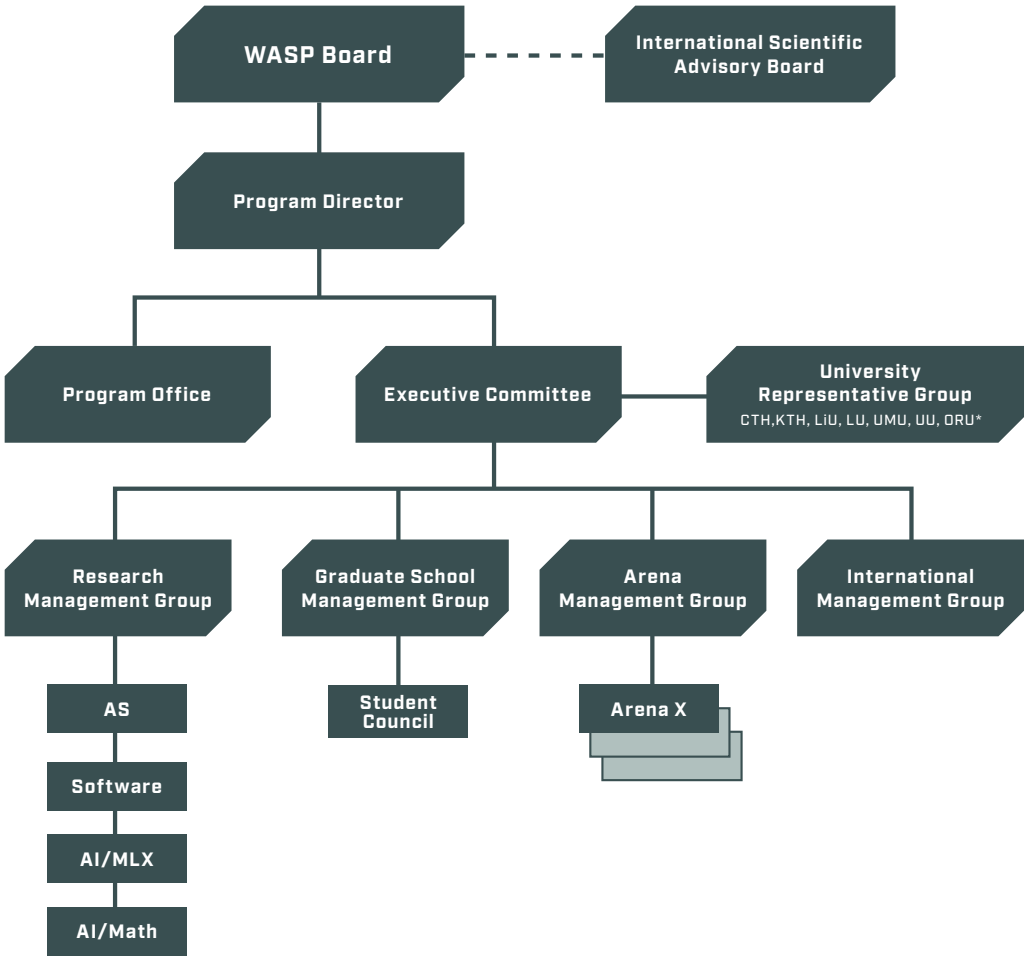
- International recruitment of 9 professors in autonomous systems and software.
- Top level recruitment of 9 Wallenberg Chairs in AI: 5 full professors and 4 guest professors.
- International recruitment of 22 assistant/associate professors in AI.
- Development of the graduate school curriculum and network.
- 337 admitted PhD students, 236 academic PhD students, 101 industrial PhD students, and 63 affiliated PhD students. To date 10 students have completed their doctorates.
- 40 companies engaged in WASP.
- Research arenas in public safety and in common cloud are in operation and arenas in software and media are in the start up phase.
- New research instruments started, as WASP Expeditions, AI Collaboration projects, and a initiative with NTU Singapore.
- Collaborations and exchanges with Stanford University, UC Berkeley, NTU Singapore, and initial exchanges with MIT.
- Three new initiatives aimed at WASP PhD students approaching their exams: a postdoc program for continued career, an industrial network program, and a program for initial stages of innovation in terms of validation research.
- A new, independent sister program, WASP-HS, for research in humanities and social sciences in WASP related areas.

With a new large donation from KAW on November 21, 2019, WASP now has a total budget of 5.5 billion SEK. The large grant of 1295 million SEK and the extension to 2030 will allow WASP to start further instruments and also to build towards a longer time horizon. Thus a new and updated strategy is being formed.

2.5 Organization

The WASP Board is appointed by Linköping University, the hosting-body for WASP, and has representatives from the WASP Member Universities and from Swedish industry. The Program Director is the executive leader of the program and is responsible for managing and developing the program in close collaboration with the University representative group, the Research management groups (AI, AS, Software, and Math), the Graduate School management group, the Arena management group and the Internalization management group. A PhD student council provides an interface to the program leadership for students. The WASP management, along with researchers and PhD students active within the program, is supported by a Program Office regarding coordination, communication, administration and financial matters. The program is strategically evaluated each year by the International Scientific Advisory Board (ISAB) that provides feedback with the aim to guide the development of the program.

WASP Governance Structure



* Chalmers University of Technology, KTH Royal University of Technology, Linköping University, Lund University, Umeå University, Uppsala University, Örebro University

3. Situation Analysis and Outlook

3.1 Society and Industry 2030

The long term vision and strategy of WASP is strongly rooted in future perspectives that relate to both industry and to society at large. The past decades have witnessed technological disruptive changes as a result of progress in fundamental research as well as enabling technologies. It is therefore of utmost importance that WASP positions its strategy within a larger context by identifying where the program can achieve the greatest impact while consolidating the strengths of academic talent and Swedish industrial interests. A useful starting point is to examine how the next decade will be changed in terms of advanced technologies from the various perspectives of (a) the individual citizen, (b) society and (c) industry.

CITIZEN PERSPECTIVE: In 2030 societal services will be based on increasingly pervasive and data driven intelligent systems with natural interfaces exhibiting human-style communication interfaces. Typical examples of this are healthcare services which can be expected to undergo dramatic changes, of course, due to advances in medical science, but also due to advances in widespread collection and availability of data combined with maturing AI-based decision-support systems. Robotics and automation will be used to complement human abilities in a variety of tasks, and will be more readily available for the individual to access. Furthermore, citizens will be exposed to and interact with intelligent systems not only at work, but also in education, entertainment, and cultural activities. Services will also be built on highly trusted technology and methodology ensuring privacy and integrity.

SOCIETAL PERSPECTIVE: An important example of societal change in 2030 is the realization of the fully instrumented urban area and smart city. Autonomous logistics and traffic control will be enabled by massive deployment of multi-sensor fusion networks with high speed reliable and secure data communication and distributed processing power. This will lead to improved traffic flows, environmental control, and increased safety and security. It is also important to address the common global challenges best articulated by the UN's sustainable development goals. The potential for many of the future enabling technologies to help us to confront these challenges is not only significant, but may be essential.

INDUSTRIAL PERSPECTIVE: One of many examples of potential disruption in industry is the emerging infrastructure for exchanging and sharing data. Industries will benefit from sharing and using data across the value chains both to better predict demand and supply description. The service industries will dramatically change their way to interact with and among customers. This will affect everything from the media and entertainment industry to retail and banking. Exchanging and or buying/selling data will possibly enrich the different actors' value proposition and could even lead to new business models. Furthermore industry resilience can be obtained through technology enabled flexibility, leading to dynamic responses to extreme and rapid changes in the market. Automation and intelligence will also be one of the main drivers behind the disruption of core production and service processes in a range of traditional and emerging industrial domains.

3.2 Enabling Technologies

From the above perspectives we have identified the following core technology positions which will be necessary in realizing these scenarios:

T1. Increasingly advanced distributed, networked, linked, real-time technologies and services will provide the core of the information infrastructure and must be fully pervasive.

T2. Services must be linked, interoperable and consist of a complex hierarchy of systems of systems (of systems).

T3. Integration of techniques from AI, autonomous systems, and software is required to develop the intelligent systems and services of the future.

T4. Infrastructures for creation, curation, availability and processing of data will play a central role in workflows and value chains.

T5. Advanced human-in-the-loop technologies must provide the machinery and interfaces for collaboration, coordination, steering and control to support human reasoning and decision making in a social context (including e.g., regulations, law, ethical and moral standards).

T6. High levels of secure and robust software solutions must be integrated into all systems and services both at the infrastructure and at the architectural level.

T7. Society will be instrumented with sensors and data will be handled through distributed processing and real-time technologies as a part of the infrastructure.

T8. Autonomous decision-making based on a combination of data and prior knowledge plays a central role in systems and services.

The main focus of current research within WASP is artificial intelligence and autonomous systems acting in collaboration with humans, adapting to and learning from their environment through sensors, information and knowledge to form intelligent and secure systems-of-systems. Software is the main enabler in these systems and is an integrated research theme of the program. The research currently taking place under the WASP umbrella can be clustered into a number of core technology areas and application domains which form the basis for categorization and clustering of projects and PhD students. Whereas the core technology areas are application agnostic, the application domains mirror the development of WASP. When WASP started in 2015 the focus was on the systems developing industries in Sweden, such as Ericsson, Saab, ABB and the automotive industry (e.g. Scania, Volvo AB, Volvo cars). When AI was added as a separate focus area in 2018, the scope was widened to include all industrial sectors. This caused the addition of applications in, for example, finance and pharmaceuticals (e.g. SEB, AstraZeneca). There are, however, still several sectors that are largely missing in WASP although WASP remains open to them. Examples include media, entertainment, and services. The main reason for this situation is a lack of strong proposals to WASP's open calls from these sectors, and further analysis and outreach activities are most likely needed.

3.3 Other Wallenberg Initiatives

Another important aspect for the situation analysis is to put WASP in relation to other ongoing Wallenberg research programmes. Currently, the Wallenberg foundations are the major private funder of research at universities in Sweden with annual funding of approximately 2.5 billion SEK. The Knut and Alice Wallenberg Foundation (KAW), the largest of the Wallenberg foundations, will invest at least 7 billion SEK in strategic research programs in science and technology over the coming ten years (2020–2030). The largest program is WASP (4.2 SEK billion) followed by WACQT (Wallenberg Center for Quantum Technology) (1 billion SEK), Mathematics (500 million SEK)

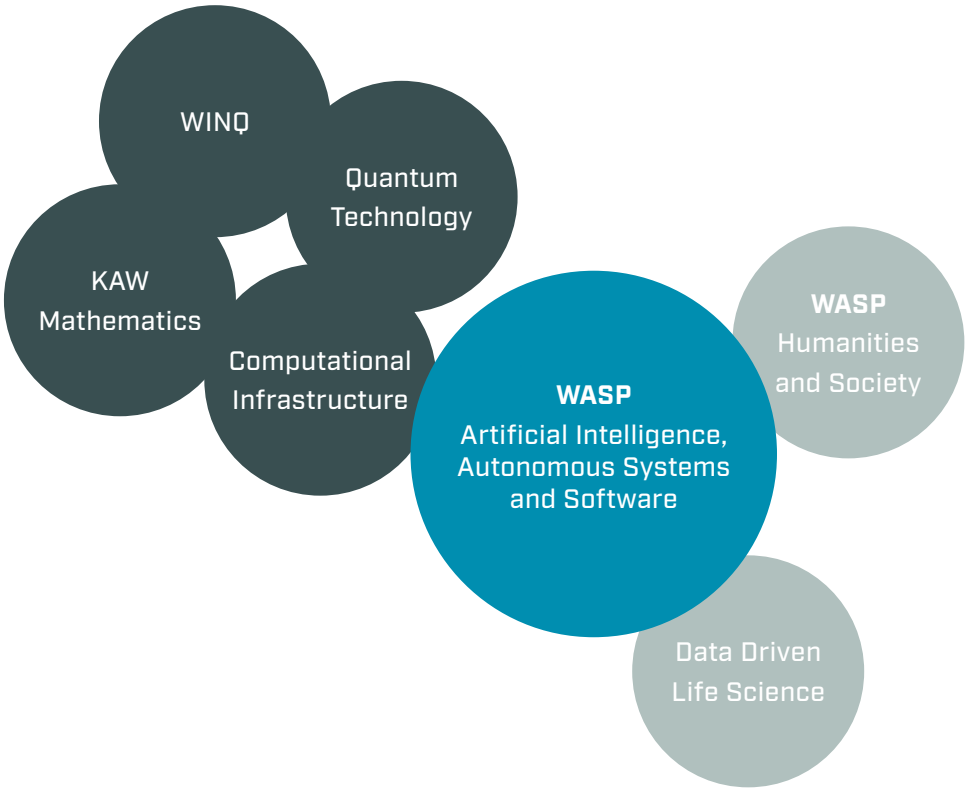


Figure 3.1: Related initiatives funded by the Wallenberg foundations

and Theoretical Physics at Nordita on the topic "Physics for Computing and Computing for Physics" (200 million SEK). Together these strategic initiatives form a network of competence in the areas of AI, autonomy, computation and software as well as their foundations in mathematics and physics. In 2020, the Knut and Alice Wallenberg Foundation (KAW) announced a 3.1 billion SEK 12-year funding initiative to support data-driven life science, DDLS.

The WASP-HS (humanities and societies) program aims at extending and complementing the technological research and advances on AI with a strong investment on research in social science and humanities. This research program is funded mainly by Marianne and Marcus Wallenberg Foundation, and Marcus and Amalia Wallenberg Foundation with an investment of approx. 660 million SEK. The WASP-HS program is planned to run until 2028 and forms an independent and parallel program to WASP, while maintaining a close dialogue with the WASP program.

All of the above described initiatives provide a context with multiple opportunities for in-depth exchanges and collaborations for WASP over the next decade.

4. Wanted Positions and Strategies

4.1 Wanted Positions

To place WASP in the context of the vision and underpinning technology trends described above, we define nine wanted positions for WASP in 2030. The starting point for the definition of the positions is the main mission for the program, which is to work towards the betterment of Sweden and, in particular, to the benefit of Swedish industry. The wanted positions are therefore expressed as positions for Sweden, but from the perspective of the WASP scope and research domains covered. The underpinning intention is that the success of WASP is measured in terms of significant, and in some cases main, contributions to the national journey towards these positions.

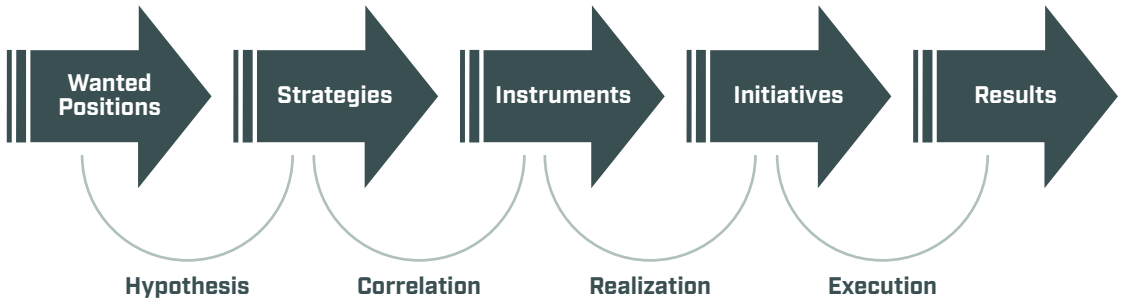


Figure 4.1: The causality chain from wanted position to results

The chain leading from a wanted position to results and impact is shown in Fig. 4.1. Once the wanted positions are defined a set of strategic efforts, the vehicles required to reach the positions, are defined. These form the basis for the instruments. Below we briefly introduce the wanted positions and the corresponding identified strategies:

P 1

AI-AS-S research in Sweden has generated far reaching impact in society and industry and has thus been a key component in maintaining Sweden's role as a leading digital nation

STRATEGIES:

- Fund research addressing strategic societal and industrial problems
- Foster collaborations and networks with industry, and between academic disciplines
- Continuously analyse needs and trends to position Sweden at the forefront of the international research agenda in this subject area

P2

The general level of AI-AS-S research in Sweden is at the international forefront both in terms of quantity, quality and coverage of strategic areas

STRATEGIES:

- Operate with dynamic funding instruments that balance between quantity and quality, and follow along a strategic dimension
- Have wide coverage of research domains in project selection
- Apply an open and competitive process for the selection of projects
- Conduct evaluations and follow-up of project results and their impact

P3

Swedish universities host a large number of internationally renowned scientists (senior as well as junior)

STRATEGIES:

- Provide attractive career paths for promising junior researchers
- Recruit top international researchers in strategic areas
- Build-up strong and attractive hosting research environments
- Host networks of excellence including academic researchers and industrial partners
- Offer postdoc opportunities in Sweden and repatriation opportunities
- Promote gender balance in recruitments and appointments.

P4

Sweden offers the most attractive PhD program in AI-AS-S for national and international students

STRATEGIES:

- Operate a national graduate school with a coordinated syllabus
- Engage the best teachers to offer courses on central topics
- Offer both broad courses accessible to many students as well as specialized courses
- Provide mechanisms for networking among students, with academic groups, industry, and the international research community
- Actively promote recruitment of graduate students of underrepresented gender

P5

Sweden has world-leading research environments, networks and laboratories in AI-AS-S

STRATEGIES:

- Fund environments with the best researchers who have a focused research agenda
- Build-up networks of excellence in strategic research domains
- Offer attractive packages for international recruitment as well as retention of Swedish talent

P6

Swedish industry is thriving at the top of innovation and competence, accelerated through exchanges of knowledge and in-depth collaboration with universities

STRATEGIES:

- Operate joint academic/industrial research arenas
- Fund shared positions for academic/industrial mobility
- Host networking events to identify synergies and joint projects
- Form strategic alliances with top international universities

P7

Successful spin-off companies are continuously being created in Sweden and strengthen the attractiveness and competitiveness of the Swedish industrial environment

STRATEGIES:

- Take commercialization aspects into account in reviewing and the creation of incentive mechanisms
- Form alliances with innovation and commercialization support organizations
- Provide information to PhD students on commercialization possibilities
- Fund proof of concept research

P8

Sweden is a premier partner in strategic alliances and exchanges with worldleading universities, organizations and companies in these areas, leading to investment in Sweden

STRATEGIES:

- Participate and take a leading role at the EU level
- Operate a program for exchanges of students and researchers with leading universities and companies
- Coordinate, package and communicate Swedish opportunities
- Form strategic alliances with international top universities

P9 Sweden is leading by example and serves as a role model for other countries and participates in the formation of the international agenda for future directions of AI-AS-S by hosting meetings, conferences and policy bodies

STRATEGIES:
- Support organization of conferences and networks
- Document and communicate success stories and organizational concepts
- Engage in international policy bodies

4.2 From Wanted Positions and Strategies to Instruments

The challenge for a program working towards the stated positions and the identified strategies, is to define the instruments that will contribute, both directly and indirectly. The initial WASP instruments, as described in section 2.4, have evolved over time and have already had a significant impact on the Swedish position in Artificial Intelligence, Autonomous Systems and Software. An analysis conducted in 2020 gave a comprehensive overview of the status of the program and provides valuable input for future development of the program in terms of refinement of instruments. The main conclusions that can be drawn from that analysis were:

- It is clear that, for the most part, the WASP instruments all contribute to multiple wanted positions. Thus, the current instruments are well justified, but the analysis indicates a potential for further improvement and tuning.
- Industrial relevance and collaboration should be increased across the instruments and research arenas should be given attention to reach the full potential.
- New instruments addressing research environments and networks of excellence should be considered, and career paths for junior researchers should be supported.
- A diversity and inclusion action plan needs to developed and enacted upon.

Based on these conclusions, a number of refinement actions were developed for each of the existing instruments and a number of new instruments are proposed for 2021. Each of these are briefly outlined in the next chapter.

5. New Instruments 2021

5.1 WASP Graduate School

Based on the results of the conducted analysis, several improvements have been made to the WASP Graduate School. The most significant change is the proposal of joint curriculum, rather than two separate tracks. The new curriculum, although applied for all new WASP students, still preserves flexibility and allows for more choice for the students to adapt the program to their interests and background. It is also constructed such that there is an increased flexibility in admitting students throughout the year from all the research topics within WASP.

The curriculum consists of one course that is mandatory for all (Ethical, Legal, Societal and Economic aspects on AI and Autonomous Systems) and three foundational courses in AI/ML, namely, Autonomous Systems, and Software Engineering and Cloud Computing. Of the foundational courses, students are obliged to take at least two of the three courses offered. The graduate school then offers at a minimum ten possible elective courses. The mandatory and foundational courses will be given every year and the elective courses every second year. Each student is required to take five WASP courses, in total 27 credits. This means that besides the mandatory and the two foundational courses, each student needs to take two more WASP courses.

To facilitate interaction and strengthen the WASP identity among the students, the first summer school is a community building event and every semester there is one joint course session where many courses are co-located to provide a natural meeting place for the students.

The activities such as the Winter Conference, a theme-based summer school, and international study trips will continue as before.

The new curriculum will apply to all PhD students starting the second half of 2021. Existing PhD students will be given the option to switch to the new curriculum.

5.2 New Cluster Model

The starting point for the new structure follows an identification of core technology domains and application areas in WASP. After additional input from the PhD students a number of cluster topics have been defined. Three types of clusters will be supported.

The first is the core technology clusters coupling PhD students with similar research topics together. A core technology group is typically of the order of 10 PhD students and can be headed by a senior PhD student or a WASP postdoc. It is expected that the core technology groups have frequent meetings and organize joint activities such as paper reading groups etc. As most PhD students in WASP also have one or several applications in focus it is also suggested that application clusters are formed. An application cluster brings together PhD students from different core technologies, addresses application specific challenges and catalyzes multi-disciplinary approaches within an application domain. An application cluster can be a larger group of students and senior researchers and with industrial representation. It is also possible to connect application clusters to the research arenas to leverage efforts in arenas with cluster activities. The final type of cluster is the area cluster. These are similar in structure to the application clusters and have the aim to gather PhD students and WASP faculty working within an area that is substantially larger than a core technology cluster but not specific to a particular application domain. Some examples are security, software engineering, and cloud technology.

A goal of the new structure is that it should be more flexible and dynamic than the existing one. It should be easy for the students to change cluster and propose new clusters. The clusters will also be evaluated annually. Since the clusters are mainly for the benefit of the students, participation is not mandatory.

5.3 NESTs

As indicated by the analysis of wanted positions and instruments it is clear that even though there are many instruments in WASP that will generate the components out of which leading research environments and networks are formed, there is no single instrument that has this as main focus. With a starting point in the identified technology trends we propose to include such an effort under the research program instrument. It has been given the name WASP NESTs, where NEST stands for:

- **Novelty:** Addressing specific strategic research challenges with international impact and visibility.
- **Excellence:** Engaging top researchers in Sweden and their collaborators world-wide.
- **Synergy:** Finding collaborations between environments, with companies and arenas (WARA).
- **Team:** Forming constellations of the best researchers across multiple disciplines with a common goal, and creates "homes" for recruited WASP researchers. Can be a physical environment or a network of excellence.

The NESTs should be based on the selection of a number of WASP technology areas aligning with the prioritized areas presented in Section 3.2 that are of key interest to Swedish industry, and where Swedish research could have an international impact. NESTs will be appointed after an open call for proposals and evaluated by a panel of international experts. A NEST should be granted funding for a time period of at least 4 years and provide adequate funding for supporting a group of researchers.

5.4 WARA Forward

As indicated in previous analysis and reports, an understanding has matured that the wanted impact of the investment in WARA has not yet been fully met. The analysis in the fall of 2019 and beginning of 2020 has concluded that the basic objective is still valid but that the strategy has to be evolved. To attract industry engagement, the respective contexts have to be closer to the reality which the industry experiences. Also, for the academic engagement, the WARAs have to be more integrated and leverage on the other parts of the WASP program and focus should move towards senior academic and industrial researcher collaborating, advising students in the context of the arenas and scenarios.

In addition, it is also clear that another category of arena is asked for, that is the development of basic general purpose technology e.g. SW technology, Cloud infrastructure etc. In this case the participants and driving forces are quite different from that of a more industrial context and this has to be acknowledged and addressed.

At last, for leading industry representatives and senior researchers to meet and to find common grounds for collaboration projects, new activities have to be initiated such as conferences, seminars etc. For example the possibility to conduct smaller so-called "bridging" projects with the help of limited engineering efforts has been asked for, both in the context of the arenas, and in a wide range of collaborations outside of the defined arenas. This has lead to the definition of the "Industry Bridge" instrument, as a complement to the arenas, and described below.

5.4.1 Research Arenas 2.0

With a starting point in the experiences of WARA public safety and the analysis performed a new concept for the arenas has been developed. Central in this concept are:

- Build on five to eight new smaller arenas with a more focused context and possibly limited in time.
- Seek and leverage on industrial/institutional motivation and ownership.
- Integration of WARA in other WASP instruments, such as industrial PhD projects described in this section.
- Two categories of arenas have been identified: systems demonstration with high industrial relevance and general-purpose technology platforms to serve as research infrastructure.

The detailed plans for the research arenas 2.0 are being developed and the two first WARAs that have been approved by the WASP board are new arenas in the areas of software and media.

5.4.2 Industry Bridge

A flexible instrument to increase the number of participating companies is seen as an important addition to the WARA portfolio. Funding of engineering time to implement research results for proof of concept research has been identified as a bottleneck in bridging the gap between research groups and industry. In many cases a limited effort in terms of man months would explore the possibilities offered and form the foundation for longer and deeper collaborations, and participation in the other instruments such as research arenas or industrial PhD projects.

A new instrument is proposed to address these items and is based on:

- A collaboratively defined win-win project involving at least one academic and one industrial WASP partner.
- Funding of engineering time at three levels 3, 6, 12 months.
- In-kind contributions from the industrial partner.
- Connection to existing WASP research projects.
- Relevance to research arenas.

To identify industry bridge projects the intention is to organize industry/academia match making meetings, which will generate proposals for consideration by the board.

5.5 Career Program

Until 2030 at least 600 PhDs will be admitted to WASP. It is in-line with the WASP mission that many of them will find career opportunities in industry and thus serve as personifications of the industrial relevance of WASP. However, some academically outstanding PhDs will look for careers at universities and may form the basis for the next generation of research leaders. An instrument for support of the top tier PhDs can be a way to leverage other investments made and capitalize on the vast pool of highly competent WASP alumni. Assuming that 10% of the WASP PhDs would be of this caliber and have an interest in pursuing an academic career 40 would be eligible to apply. A 25% acceptance rate would mean that 10 establishment packages (similar to WASP recruitment of assistant professors) would need to be made available.

5.6 Diversity Action

Efforts are launched to address diversity aspects of WASP. The most urgent is the gender inequality currently present in WASP and its partner sites. These efforts should be based on practical suggestions for how to improve gender equality within the natural sciences and have been drawn from research on how processes of discrimination and privilege appear in scientific working practices at different points in the career trajectory. It is thus proposed that WASP should strike a Diversity and inclusion group with the task to propose concrete actions and integrate them in WASP instruments and other activities. The starting point for the group are specific places where WASP can engage with new strategies to redress current inequalities.

Proactive recruitment practices and career support are the most important places where WASP can make a difference. Additionally, WASP needs to reflect on how we enact implicit bias in our practices, where and when it appears in the various processes and critically assess the impact implicit bias has on selection. Based on the insight, WASP will strive to form new criteria to be applied in reviewing. Additionally, WASP will be working in dialogue with our colleagues at the various universities to lift questions about how researchers of underrepresented genders (and ethnic groups) are retained, supported and promoted. Of course, this means asking about whether internal resources are distributed fairly, about the transparency of promotion decisions and about the conversation climates.

6. WASP Beyond 2030

By 2030 Sweden aims to be a leading nation in AI, Autonomous Systems and Software in Europe, and home to several of the world's leading research groups within the areas. An important component in this ambition is that a subset of Swedish universities will be among the top 10 in the world in subject rankings connected to WASP. Swedish industry will also be world leading in the technology sector with several global companies having their origins in Sweden. The ambition is that WASP will have served an essential role in positioning Sweden as a globally competitive nation, and the WASP initiative will be in a position to serve as a model for future research and education programs in science and technology.

As we move beyond 2030, WASP will have shown an added value and will be sustained by the Universities through excellent research environments and via other funding initiatives which bring together academia and companies. It is projected that three important aspects will persist beyond 2030:

- **Research Excellence:** By 2030 WASP will have led to the establishment of more than twenty sustainable high profile research environments, producing internationally competitive research. Beyond 2030, these research environments will be active in forming new national and international research collaborations and will be aiming towards the next level in major national and international recognition in the research community. WASP has already resulted in outstanding quality scientific output in AI, autonomous systems and software in Sweden, and there are many more successful scientific breakthroughs to be made based on high risk, high reward WASP projects.

- **Strategic integration of WASP within the Swedish universities:** The WASP Graduate School will have resulted in an even more attractive engineering education at all levels, reaching larger numbers of students and resulting in a very positive image of Sweden. The groups hosting the WASP recruits will be essential components in the development of strategic research efforts within the universities. Many of the graduated PhD students will have faculty positions at renowned international universities and, upon their return to Sweden, career opportunities will be available. This close interaction and integration of WASP with the participating universities also paves the path for university ownership of WASP.

- **Societal and industrial impact of WASP research:** The major societal and industrial impact of WASP is evidenced by the education of very talented researchers and engineers. The continued development of digitalization technologies will be a key component in the transformed Swedish society and industry over coming decades, and the WASP legacy will be maintained through renewed initiatives and university commitment to the field.

To conclude, the success of WASP will to a large extent be shown in the impact the program has had until 2030 and how well the strategies have worked towards the wanted positions, but also in the persistence beyond 2030 of the WASP initiative and the long term effect it has had on the development of Swedish research.