NRIA Flyg 2016

New challenges – and new solutions

The Swedish
Aeronautical
Research and Innovation
Agenda

ABOUT THIS DOCUMENT

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TERMS AND ABBREVIATIONS

ACARE Advisory Council for Aeronautics Research in Europe – a council for strengthening European aeronautics.
ATI Aerospace Technology Institute – the United Kingdom's counterpart to Innovair, an organisation that oversees strategic aeronautical innovation.
Clean Sky Joint Technology Initiative/Public-Private Partnership within the EU concerning environmentally-friendly air transportation. Formally exists in its current form as Clean Sky 2, with a budget of EUR 4 billion and oriented towards the verification of innovative technologies and new concepts in full-scale flying demonstrators.
Dual use The utilisation of technologies within two sectors, e.g. civil and military aviation. Also see *triple use* and *multi use.*
EDA European Defence Agency.
FCAS Future Combat Air System.
FLUD Aeronautical Development and Demonstration Programme.
FMV The Swedish Defence Materiel Administration.
FOI The Swedish Defence Research Agency.
GF Demo Green Aeronautics Demonstrator Programme.
IFFP International Aeronautics Research Programme.
ITA Instituto Tecnólogico de Aeronáutica, Brazil's aeronautical university in São Jose dos Campos.
MoU Memorandum of Understanding.
Multi use Utilisation of technology in several different technology areas. Also see *dual use* and *triple use.*
NFFP National Aeronautics Research Programme.
NRA National Research Agenda.
NRIA National Research and Innovation Agenda.
OECD Organisation for Economic Co-operation and Development – an international organisation for the exchange of ideas and experience within fields related to economic development between democratic industrial nations with market economies.
OEM Original Equipment Manufacturer – companies able to manufacture complete multi-component products which are produced for an end-user.
R&D Research and Development.
SESAR Single European Sky ATM Research – an EU programme that develops technical and operational conditions for shared European airspace. Currently exists as SESAR2020.
SFP Strategic Research Programme.
SIP Strategic Innovation Programme – presently comprising 16 strategically prioritised areas of great significance to Sweden's innovative development and competitiveness.
SME Small and medium-sized enterprises – typically consisting of 1–250 employees.
Oblique wave principle The manner in which technology readiness levels (see TRL) change over time, from basic research to technological integration and full technological maturity. By implementing concurrent investments at various readiness levels and in different contexts, a continuous provision of technology between parallel oblique waves can be achieved. Refer to NRA Flyg 2010 and NRIA Flyg 2013 for details.
SWE Demo Swedish Aeronautics Demonstrator Programme.
Syncrete innovation Innovation resulting from all decision-making owners having the same perception of the innovation area, its benefits and its prerequisites. Can be linked to *Syncretism,* i.e. the amalgamation of religions/beliefs systems, as well as to *synchronised* and *concrete* innovation.
Triple use The utilisation of technologies in three technology areas, e.g. within civil aviation, military aviation and a third area. Also see *dual use* and *multi use.*
TRL Technology Readiness Level. Refer to NRA Flyg 2010 and NRIA Flyg 2013 for details.

DEFINITIONS

Innovation New approaches or ways of thinking that result in a marketed product or service.

Innovation capability The ability to convert knowledge, competence and ideas into new solutions in order to meet needs and demands as per the above.

Innovation system System of functions that together ensure that innovation can be realised as per the above.

Research Scientific study – an active, systematic and methodical process conducted by researchers in the pursuit of new knowledge and to increase understanding.

R&D Research and Development – activities spanning the entire chain from idea to finished product and in which new and previously employed technologies are explored and developed.

Technology area Area encompassing business, industrial and professional operations in which the development of shared technology is central.

Aeronautics Technology area constituting the development and manufacture of aircraft, aircraft engines, associated subsystems, and the systems and methods employed in air traffic control.

Market The collective global demand for aerospace products and services to which research and innovation in Sweden must be oriented in order to meet these.

DELIMITATIONS

- NRIA Flyg 2016 employs the perspective that research and innovation should be "useful" in that they result in products, services and systems which respond to market needs.
- The document represents the collective aeronautics area, not its individual players. The agenda deals with shared interests – not individual interests.
- NRIA Flyg is not solely concerned with innovation in the fields of aeronautics and aviation. Our ambition is to have a broader approach and discuss innovation from a national perspective. Therefore, a significant portion of the innovation agenda deals with measures to establish prerequisites within, for example, the public sector, which is expected to produce positive effects in other areas aside from aeronautics, and perhaps primarily in those areas administered by other strategic innovation programmes.

IN SWEDISH

A Swedish version of this document is available for download from **www.nriaflyg.se**.

This year's aeronautical innovation agenda

Aeronautics and aviation are at the forefront of societal development and embody several of the most exigent societal challenges. On a global level, the rapidly growing aviation industry is considered one of the predominant sources of climate change. At the same time, aviation is a colossal industry with an ever-growing market, in which Swedish players have a significant opportunity to contribute to export, jobs and growth. Whatever the approach, effective innovation is a key factor.

As in previous agendas, this year's aeronautical innovation agenda, NRIA Flyg 2016, convenes the players involved in the field of aeronautical innovation and analyses the possibilities for effective innovation – and the prerequisites thereof. The overall ambition is to promote aeronautical innovation and development in both the civil transport sector and

the defence sector, and to be able to understand, describe and expand the innovation system for aeronautics in particular – and for Sweden as a whole.

There are a few important reasons for carrying this out on a recurring basis, such as in the three-year cycles we have opted for. This is, in part, due to a strategy document conveying that to be carried out and, because these issues are then later actually carried out, the strategy must subsequently be updated. Another reason is that the world around us is not static – new circumstances arise which necessitate that the strategy be modified.

This year's agenda is therefore based on the long-term goals and recommendations from previous agendas and substantiates the need for additional strategic activities to be planned and executed – based on analyses of the most important changes in the area of aeronautical innovation.

Over the 2016–2020 period, the area of aeronautical innovation – under the collective leadership of Innovair – shall:

- supplement the existing innovation system with respect to the relationships between prioritised regional, national and international players;
- strengthen international cooperation – beginning with a focus on Brazil, the United Kingdom and the EU.

These prioritisations will result in Swedish aeronautics contributing to Sweden's position as a leading nation as regards knowledge and skills and address major societal challenges being faced domestically and globally, producing further societal benefits, increasing environmentally adapted technological solution exports, strengthening military aviation's politico-security role, creating more skilled jobs and raise the welfare of Sweden – in line with *The National Innovation Strategy* (N2012.27), *Sweden's Export Strategy* (UD 15.031) and *Smart Industry – A New Industrialisation Strategy for Sweden* (N2015.38).

For this to be possible, this year's agenda offers a number of recommendations (see below and page 30). By introducing these recommendations, the Swedish innovation system takes a substantial leap in becoming complete regarding effective collaboration between academy, companies, and government. This leads to a greater return on invested tax revenue and results in long-term competitive advantages for Sweden.

OUR RECOMMENDATIONS IN SUMMARY

We propose: that Vinnova and the Swedish Armed Forces are mandated to fund the 7th iteration of NFFP, for the years 2017–2021, at – at least – the same level as NFFP6, and with an equal proportion of co-funding from business and industry.

We propose: that Vinnova, preferably jointly with the Swedish armed Forces, is mandated to fund an international aeronautics research programme (IFFP) at TRL 2–4 in order to support bilateral partnerships with prioritised nations.

We propose: a reinforced and steadfast continuation of the current SWE Demo programme in the form of a series of successively adapted programmes in order to position Swedish industry in international demonstrator programmes.

We propose: that the Swedish Research Council is mandated to fund a strategic research programme (SFP) for aeronautics at TRL 1–2 with SEK 30 million per year for five years to safeguard the fundamental base in our innovation system.

We propose: the establishment of an interdepartmental work group for aeronautics made up of responsible officials from the Ministries concerned.

We propose: the establishment of a joint technology council for strategic innovation programmes naturally predisposed to work together.

We propose: that the regions, the Swedish Agency for Economic and Regional Growth, and participating companies ally to create an SME cluster for all aeronautics and aviation companies in the country.

(See these recommendations as a whole on page 30.)

Two previous agendas

» A starting point for this year's strategic aeronautical innovation agenda rests in the fact that we have already written two agendas over the last six years: NRA Flyg 2010 and NRIA Flyg 2013.

NRA Flyg 2010

The 2010 strategic innovation agenda – or research agenda as it was known then, even though it dealt with the entire innovation chain – was undertaken wholly on the aeronautical innovation area's own initiative.

The agenda focused on *unanimity in the innovation process, frameworks for aeronautics strategy, research programmes and financing*, as well as *aeronautical expertise*. The document was characterised by consensus with respect to that which the contributors wished to accomplish.

The agenda was very well-received and was considered to be a trendsetter for strategic innovation agendas, not least because it demonstrated substantial unanimity within the innovation area.

The most important results of the 2010 agenda constituted the creation of a national demonstrator programme to bridge the gap between research and product development, and the establishment of a triple use programme for focused innovation with development and applications in several areas other than our own civil and military aviation applications. In addition to this, uniform technological prioritisation was also effectuated within the area, and the foundation was laid for a national association of innovation players within aeronautics.

Long-term goals were established for 2040, and short-term goals for 2020. All established goals were achieved, apart from those for military demonstrators.

NRIA Flyg 2013

The 2013 iteration of the strategic aeronautical innovation agenda was created within the framework for development of strategic innovation agendas as called for by Vinnova, the Swedish Energy Agency, and Formas.

That year, the agenda recommended five demonstrator programmes, the establishment of aeronautical production arenas and research networks, as well as the creation of a formal shared platform for the coordination of innovation.

All proposed activities, save one, were realised and SMEs gained improved conditions owing to the creation of special research programmes and through support activities within Flygsverige's (collective term for Swedish aeronautics and aviation) two production arenas: PTC Innovatum in Trollhättan and Compraser Labs in Linköping.

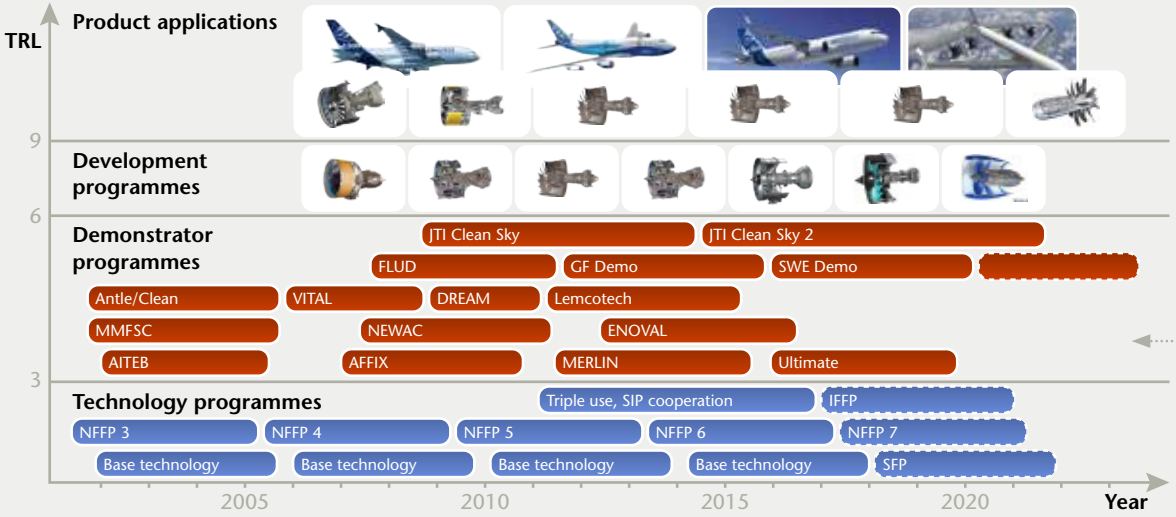
The unrealised recommendation was the proposed military demonstrator. However, there remains a need for this in the near future to facilitate the development of FCAS, which is

OUR PREVIOUS AGENDAS

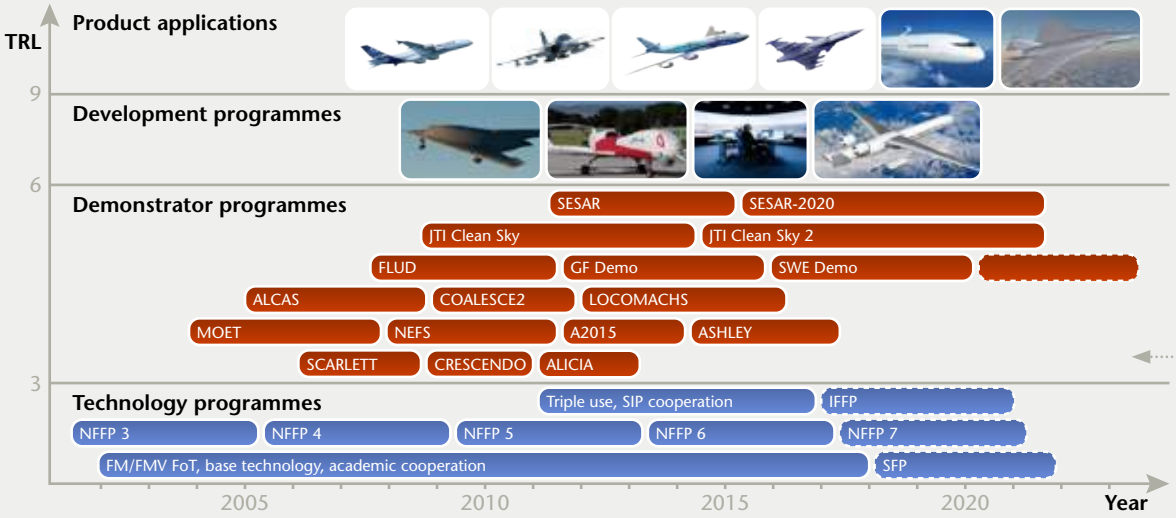
NRA Flyg 2010 (only in Swedish):
www.nriaflyg.se/nraflyg2010
NRIA Flyg 2013 (in English):
www.nriaflyg.se/nriaflyg2013e
Our view of the innovation system (in English):
www.nriaflyg.se/innovsys2013e

AERONAUTICS WORKS!

We can confirm that our toolbox contains the correct tools to describe and administer innovation by introducing actual national and international research and demonstrator programmes, development programmes and products into the market via the oblique wave principle. We then attain something we refer to as *effect logic.* This effect logic is shown below for a few of GKN and Saab's innovation chains. (For TRL and the oblique wave principle, see previous agendas.)



Effect logic GKN with partners (subcontractors, academia, institutes). Observe that the image is schematic.



Effect logic Saab with partners (subcontractors, academia, institutes). Observe that the image is schematic.

Read more about the dotted programmes on page 30

the aircraft system that will follow Gripen.

The agenda further expounded on the 2010 goals and adjusted the time frames: long-term goals for 2050, intermediate goals for 2020 and 2035. Major focus was directed on how the players would best achieve the established goals (both long and short-term) in conjunction with the environmental goals for 2050, which were established in ACARE's SRIA (see infobox).

The agenda was as well-received as its predecessor, and consolidated its position as the leading strategic document in Innovation Sweden. The aeronautical innovation programme conferred one of the first six national strategic innovation programmes, which enabled the association of aeronautical innovation players established in 2010 to be formalised into Innovair. Today, there is a total of sixteen Swedish strategic innovation programmes in existence.

ACARE AND ITS SRIA

ACARE (Advisory Council for Aeronautics Research in Europe) created a strategic research and innovation agenda (SRIA) which establishes a number of challenging environmental goals for 2050:

- 75% reduction in CO_2 emissions;
- 90% reduction in NOx emissions;
- 65% reduction in noise.

These targets are to be met at the same time as industrial competitiveness and leadership are strengthened.

www.nriaflyg.se/acare

Current objective

The long-term goals established in the 2010 and 2013 documents are still applicable, which was highly expected. The short-term goals have either been met, are in the process of being met or have been written off due to changed conditions.

And it is the latter this year's agenda focuses on. How have conditions changed? What are the new challenges? And what do we need to do to confront them?

Tools and models

To answer these questions we must utilise the same tools and models used in previous agendas: TRL concept (Technology Readiness Level – level of technological maturity), Oblique Wave Principle (how the TRL ladder ascends over time), and our view of the innovation system. All of these concepts are exhaustively described in previous documents – particularly in the 2013 appendix concerning the innovation system – which can be revisited if required.

PRIORITISED TECHNOLOGIES

Visit **www.nriaflyg.se/technologies** to view a table of the technologies identified as priorities in earlier iterations of NRIA Flyg – and those still being prioritised.

AERONAUTICAL CLUSTERS

Visit **www.nriaflyg.se/clusters** to see a list of the aeronautical clusters created as a by-product of NRIA Flyg 2013.

Owing to the agendas of 2010 and 2013, Swedish aeronautical innovation has a solid foundation on which to stand. But: new challenges exist which must be addressed.

New challenges

» Global development over the last few years has resulted in new ● prerequisites for aeronautical innovation. The ● solution is effective innovation, and the ● challenges exist within three main areas: cooperation, continuity and unanimity.

Prerequisite: explosive growth in aviation

According to a number of independent sources, the next 20 years will see a growth in aviation of around five percent per year, which will result in a need for more than 30,000 new +100 seater aircraft over this period – compared with the approximately 12,800 of these aircraft in operation today. The collective value of these new aircraft amounts to approx. SEK 45,000 billion.

New players with lofty ambitions exist within both civil and military aviation development. Embraer is an example of an industry evolving from newcomer to world-leader in the regional aircraft segment. Major investments being made in China, South Korea and Japan are examples of the shift from the West to Asia. At the same time, new industrial alliances are forming owing to the diminished significance of geographical distances.

This rapid growth is contingent on global trends such as a decrease in poverty and an increasing population, not least in the global growth markets, which push forward new transport and travel patterns and may result in China becoming the world's largest aviation market within a decade.

The rapid growth expected will lead to aviation's total share in the world's greenhouse gas emissions increasing from today's approximately two percent. This global growth will become a reality whether Sweden is part of the development or not. The driving-force behind Sweden's participation will therefore be our ability to develop world-leading solutions for security, accessibility, economical operation and technological development which will enable the expanding aircraft fleet to still be accommodated within the framework of ACARE's environmental targets (see fact box on page 11).

Sweden is developing technology for new aircraft and new engines through participation in Clean Sky 2 (see page 20). By demonstrating Swedish environmentally-adapted technology on European aeronautics platforms we are securing our position in the aforementioned growth. This will allow *syncretic* (see infobox) results to be achieved with respect to export revenues and contributions to reduced emissions for the aircraft and passengers anticipated. Our prospect for influence on the above issues is good; Swedish industry has the potential to supply technology,

CLEAN SKY

Clean Sky is a Joint Technology Initiative/Public-Private Partnership within the EU for more eco-friendly air transport. The present incarnation is Clean Sky 2, with a budget of EUR 4 billion and oriented towards the verification of innovative technologies and new concepts in full-scale flying demonstrators.

SYNCRETIC INNOVATION

Innovair coins the term *syncretic innovation* due to lack of a collective term to describe innovation resulting from all decision-making owners sharing the same view of the innovation area, its benefits and its prerequisites. The term can be linked to *syncretism,* i.e. the amalgamation of religions/beliefs systems, as well as to *synchronised* and *concrete* innovation.

products and services for a significant proportion of these aircraft and/or their engines. Issues pertaining to noise are being assiduously studied at the new Centre for Sustainable Aviation at KTH.

Substantial investments are being made in air transport as regards efficiency, capacity and cost-reduction within, among others, SESAR, and with an overall objective of halving costs while increasing capacity two-fold or even three-fold. Sweden has a strong role within SESAR where we, among other things, have led the work involved in remote air traffic control and green aircraft approaches and now, in the coming phase (SESAR2020), we are leading the work involved with the integration of unmanned aircraft.

Opportunities to rationalise the transport system are afforded by technological progress within automation, autonomy, decision support, remote control and interactive systems. In many cases, this development is *dual use* in nature, which entails joint military and the civil sector development, but technology dissemination also occurs reciprocally with other transport sectors such as vehicle automation, for example. Innovation within aeronautics and aviation produces a significant *spill-over* effect to other areas.

Funding for Swedish participation in Clean Sky 2 comes both from companies and from state investments in demonstrator programmes – currently SWE Demo – as well as from the EU. Similarly, the Swedish Transport Administration is part-funding Swedish participation in SESAR2020 in order to improve the air traffic system by means of remote air traffic control, the introduction of unmanned aircraft and so-called green approaches.

Biofuel, which is another way to meet environmental targets, is being studied in Sweden through, among other things, the Swedish Armed Forces' investment in biofuels in bilateral cooperation with the USA.

Prerequisite: military aviation development

An evident global trend is that certain nations with a traditionally solid defence relationship with the USA are seeking independent national capabilities for the development of advanced fighter aircraft, and consider this to be a driving-force behind a major step towards high-tech industrial capabilities. Examples include South Korea, India, Turkey and Japan.

The Swedish Armed Forces use Gripen, version C/D. In a few years' time, the next generation will be introduced – Gripen E in Sweden and Gripen NG in Brazil – with differences in avionics but otherwise very similar. Over the last few years, significant investments have been made at TRL 5–6 via various demonstrator programmes for the development of the next generation of Gripen E, the results of which have now been effectuated at TRL 7–8 and which will reach TRL 9 through the two countries' respective air forces.

A few technology areas such as sensors, weaponry and stealth technology are military-specific but, within a growing number of areas, technology is expected to be based on the ever-increasing advances within the civil sector and the adaptation thereof for use in uniquely military environments. This pertains to e.g. calculation and memory capacity, communication, display systems, and material and production technologies.

Research is under way at low TRLs for the development of future fighter aircraft and possibilities for Gripen development and/or new fighter aircraft systems after Gripen (FCAS), but also for other systems that support or complement fighter aircraft, such as reconnaissance. The development of future fighter aircraft necessitates military cooperation with one or several nations, and present-day Gripen users could be natural partners. Pan-European efforts continue via EDA; here the first major investments in a new system are expected to be directed towards unmanned aircraft, as this offers unprecedented possibilities for European defence capabilities.

Military investment in unmanned aircraft can be expected to gather much technology from the enormous advances in remote-controlled aerial vehicle systems occurring within the civil sector at present. Swedish industry is well-positioned both to participate in and lead this development.

Solution: efficient innovation

The focus for aeronautical innovation agendas has always been on *streamlining* innovation, both in proprietary chains and in the Swedish innovation system as a whole. The sooner innovative ways of thinking can reach the market, the greater the possibility for Swedish positioning in the international market. The reasons for this are numerous: partly for commercial reasons, and partly to build further on the reputation of Sweden and Swedish players, which in turn are prerequisites for further business. The requirement for efficiency is actualised by the aforementioned prerequisites.

A facilitator for this efficiency is *cooperation* between the players involved. We have come a long way in forging substantial partnerships within the aeronautical innovation area, but when we look at the big picture we can see that we need to think in broader terms. How can we cooperate with other nations in a productive manner?

Another facet to the problem above is the need for *continuity* in the innovation chain, and in the innovation system in general. A competitive position for Sweden on the international scene requires synchronised efforts from various quarters to produce the greatest effects possible – and thereby efficiency – for innovation.

A third facet crucial to efficiency in Swedish innovation is *unanimity* in aeronautics and aviation issues in the public realm of the Swedish innovation system. At present, different aspects of aeronautics and aviation are managed by different public entities whose intercommunication can be improved in order to avoid sub-optimisation and to create conditions conducive to efficiency.

In the following paragraphs we will be considering these aspects in turn but, as we will see, they are highly dependent on each other and cannot actually be viewed as isolated phenomena.

Challenge: cooperation

As described on page 13, Sweden is participating in aeronautical development so as to contribute our technological solutions to the environmental targets established for the future of aviation.

To be able to do this in a competitive manner, we need to create competitive leverage through technological advantages. But these technological advantages are no longer something we can hope to achieve on our own. In previous agendas we discussed cooperation *within* our own innovation system. As a natural continuation of this reasoning, and with globalisation and internationalisation redrawing our world map on a daily basis, we must now do everything we can to enhance *domestic and foreign cooperation*. We must cooperate with appropriate organisations and functions in other countries to create the conditions we require.

Cooperation allows us to jointly develop new products while also taking into account how we utilise and build on intellectual property that generates growth in Sweden and strengthens our influence internationally.

A major trend within internationalisation is new industrialisation, in which the Western world is now labouring to regain the initiative within areas of innovation which have prevailed in low-wage countries over the last few decades. This trend will prove significant within the field of aeronautics as well, particularly with regard to the rationalised production functions we have established in conjunction with aeronautical production arenas – a recommendation in NRIA Flyg 2013.

Equally beneficial efficiency gains

AVIATION AS PILOT CASE

In many parts of this agenda we employ reasoning that culminates in proposals for measures that can have great significance for Swedish innovation in general, not solely for the field of aeronautics but where aeronautics and aviation can function as a precursor owing to their advanced position.
Each technology area naturally has its own specific conditions and attributes, but if the fundamental principles regarding that which can be done to supplement the innovation system are investigated and proven, each technology area can thereafter test its solutions in consultation with various state players.
Our focus is on the fact that Sweden as a nation has considerably more to gain by jointly utilising our gained experience than as separate, competing technology areas. With the right focus, Sweden can support something much bigger than all the separate technology areas combined.

can be attained in strategic partnerships with select countries, and where we can tailor cooperation for each partnership so that participating nations are able to benefit as much as possible.

At present, Innovair has identified and initiated a pair of bilateral partnerships with Brazil and the United Kingdom.

Sweden ↔ Brazil

Brazil is a country offering Sweden a unique opportunity to develop a new and strengthened export strategy. The delegation sent to Brazil by the government in 2015 under the leadership of the Minister of Enterprise and Innovation adjudged that the country is a long-term priority for Sweden, that current aeronautics and aviation positioning makes the field of aeronautics a natural precursor, and that Gripen exports should be utilised as catalysts for collaboration within innovation even beyond the field of aeronautics. The initiative was taken to form a high-level group with backing from a supportive aeronautics committee. This was formalised during Brazilian President Rousseff's visit to Sweden in the autumn of 2015.

A great deal is already in place to ensure that the partnership will be productive: the current Swedish industrial presence in Brazil constitutes, for example, almost 70,000 employees in 220 companies. The country and its 200 million citizens have a GDP today that is only around five times that of Sweden, but is expected to develop into the fifth largest economy by 2050. Brazil possesses resources and has massive potential for growth, and is now seeking the technical know-how that Sweden can provide. Sweden is also viewed very

WHAT DOES BRAZIL HAVE TO SAY?

"Cooperation in Aeronautics between Brazil and Sweden is very useful for both countries. Brazil currently has the third largest civil aeronautical industry in the world in Embraer and Sweden has a world-class military capability. Especially by the purchase of the Gripen fighter the Aeronautics Institute of Technology (ITA) is building a long term relation with Swedish universities and industry. The intention is that activities in research and innovation will be succeeded by demonstrator activities and hopefully also future joint development of products and systems, where ITA could participate as an academic partner. It is expected that the activities at ITA will also be transferred to other industrial sectors such that cooperation between our two countries can be expanded in general."

Anderson Correia, professor and rector, ITA

positively by Brazil, which enhances opportunities for future cooperation and business.

The major points involved in Sweden's bilateral cooperation with Brazil include:

- the combination of strong competence centres and advanced industrial players;
- the explicit willingness and prioritisation from the governments – which facilitates a partnership that can provide significant efficiency gains for Swedish and Brzilian innovation;
- reduced costs and increased opportunities to achieve long-term national and bilateral targets – even in other innovation areas such as the forestry, mining, space and transport sectors.

Gripen export is the catalyst that must be followed-up with full-scale bilateral innovation partnerships in order to create fruitful prospects for these other sectors. Aeronautics and aviation are progressing with the contacts and models already established; a Swedish platform exists in Brazil in the form a bilateral innovation centre and a Swedish aeronautics professorship in Brazil.

In addition to this general positive development, the Gripen partnership is generating a unique opportunity for our two countries to jointly develop the next generation of air combat systems which, owing to long development times, must be initiated relatively soon. A partnership of this sort entails shared development costs, broader technical expertise and subsequent export orders to nations across the globe. The fact that Brazil's current aeronautical prowess lies within the civil sector while Sweden's is predominantly military in nature means that the countries complement one another as future partners.

Accurate measures will lead to Sweden retaining and further developing current Brazilian contacts so that we, even beyond 2050, are able to hold a strong position as a priority partner for Brazil. Doing nothing today will risk Sweden becoming insignificant in the future for nations such as Brazil, who would instead choose to cooperate with major aviation and aerospace nations such as the United Kingdom, Germany and France. Here we face a considerable challenge to invest appropriately at all levels in the innovation system and to create the best conditions for the partnership to extend to as many levels as possible, and that this can be generalised to multiple industries by allowing aeronautics and aviation to pave the way for other industries and businesses so that these are able to initiate similar bilateral cooperation within the shortest possible time owing to our experience gained from aeronautical collaborations.

Sweden ↔ The United Kingdom

The United Kingdom, which has the largest aeronautics industry in Europe and second only to the USA, has leading OEMs both within aircraft manufacturing and engine manufacturing. The country is home to GKN, which is the parent company of GKN Aerospace Sweden in Trollhättan (formerly Volvo Aero) and a leading high-level supplier of engine components to all OEMs in the Western world. The GKN Group has selected to situate its global research centre for engine technology in Sweden, which is an indication of their perception of our expertise and provides Sweden with major influential possibilities.

The aeronautics and aviation industry in the United Kingdom is the leading high-tech sector in the country and contributes substantially to export revenues, high-tech jobs and innovation development to the benefit of society at large. Owing to the establishment of ATI (Aerospace Technology Institute), the UK has built up a structure for the coordination of the country's overall efforts in aviation and aerospace – similarly to

Innovair, Sweden's strategic innovation programme for aeronautics. ATI manages collective state and industrial funding amounting to 3.9 billion pounds over 13 years.

Sweden has a long tradition of cooperation with the UK in the field of aeronautics as regards the development of both engines and aircraft. This cooperation has taken place bilaterally as well as within frameworks for joint EU programmes. Aside from the obvious links to GKN in Trollhättan, it can be stated that Airbus' British wing manufacturing is an important partner for Saab, that Rolls-Royce is an important partner with regard to engines, and that important subcontractors exist in the UK for parts and systems in the Gripen system. The UK is Sweden's fourth largest export market. Historically, Sweden and the UK have had strong unanimity and a similar approach within EU cooperation, and have been proponents of open economies and markets.

Opportunities for a bilateral partnership with the UK exist primarily with regard to production technology for components and systems of aircraft and engines, as well as in overall aircraft system development wherein the UK has invested in testing and demo facilities, so-called catapult centres, which can serve as an inspiration and as a cooperative partner for Sweden. Even here aeronautics has the potential to function as a pilot case to internationalise the Swedish innovation system so as to better confront the competitive effects of globalisation.

WHAT DOES THE **UK** HAVE TO SAY?

"I welcome this new edition of Sweden's National Research and Innovation Agenda for Aeronautics and look forward to developing the opportunities it gives for the UK and Sweden to work together. Global aerospace has unprecedented growth prospects over the next two decades, but it will continue to depend crucially on high levels of R&D, both to ensure its short term competitiveness and to develop game-changing new products demanded by airlines, passengers and citizens alike. The Aerospace Technology Institute's role is to develop a long term and challenging aerospace technology strategy for the UK, including developing the vital international links that are so important in this global industry. Sweden and the UK have a long history of cooperation both in airframe and engine technologies, further strengthened by the purchase of Volvo Aero by GKN. By joining forces our two countries will maintain and further our technological positions in the global world."

Gary Elliott, CEO, ATI

Sweden ↔ the EU

In addition to these bilateral partnerships, unprecedented opportunities for Sweden have been created owing to the Memorandum of Understanding entered into with the EU programme Clean Sky 2 (see infobox on page 13) – which was discussed in previous agendas and in which Sweden has assumed a position pursuant to established strategies – and the two Swedish regions of Västra Götaland and Östergötland. The agreement creates direct contact between these two levels in the public sector and affords unique potential benefits for both parties. It is the first time in history that a major European contributor like Clean Sky – with a project budget of four billion Euro – identifies Swedish regions as strategically important for Europe.

That being actively sought within these agreements are common synergies. This creates an opportunity for Sweden to take advantage – in a synchronised manner – of tenders based on the EU's regionally targeted structural funding and Clean Sky's forthcoming tenders. In effect, this provides all SMEs and regional production arenas with resources for cooperation towards common overall goals: innovation capabilities, increased competitiveness, skilled jobs and export revenues. Major Swedish companies attain a stronger subcontractor network and direct support for their own participation in Clean Sky's demonstrators, both with regard to engine technology and aircraft structural parts, which means that Sweden further enhances our ability to contribute to the stringent environmental targets – despite the forthcoming explosive growth in aircraft numbers and air travel (see infobox on ACARE on page 11).

In turn, Clean Sky gains access to a qualified subcontractor network that can take part and compete for future contracts throughout the European aeronautics and aviation industry. This will not only increase Swedish competitiveness but European competitiveness as a whole.

MoUs of this sort have previously only been penned in a handful of cases, and never before with Sweden. This MoU holds great promise to function as a pilot case with good potential for future generalisation within other industries. And because many industries are headed the same way as aeronautics – with high demands on adapting to an international cooperative market – we see massive potential in this pilot role. Naturally, we also face a challenge to create the best conditions for the actual cooperation aimed for by the MoU so that we are able to learn general lessons regarding the most effective way for other industries to follow the same path.

WHAT DOES THE EU HAVE TO SAY?

"The entire Clean Sky team is very happy that MoUs have been signed between Clean Sky 2 and the two regions of Västra Götaland and Östergötland in Sweden. These two regions have become the seventh and eighth European regions with which we sign such documents. Our aim is the same as yours. We want to create synergies on all levels by setting up strategic partnerships with Europe's most competent players. Sweden, with world-class industries in Saab, GKN Aerospace Engine Systems and clusters of niche companies, are natural partners in this regard. Clean Sky 2, and the entire European Union, will ultimately get access to competent partners for strengthening the 'innovation chain' while Sweden will deepen its technological skills, both in these two regions, but also on a national level. We are very much looking forward to the outcome of this new strategic partnership."

Eric Dautriat, Executive Director, Clean Sky 2

SIP

For the Swedish innovation system to function as a whole, the designated strategic innovation programmes are required – to large extent – to focus their resources and efforts collectively and in a synchronised manner. Up to the present, an initiative exists within digitalisation that has brought together the SIPs Innovair, LIGHTer, Metallic Materials and Production2030, as well as Innovair's *triple use* project, which was proposed and initiated as early as 2013, long before the strategic innovation programme became a reality.

Results from the *triple use* project were utilised within civil and military aeronautics, transport technology and civil engineering in the form of a composite material lightweight bridge. This form of cooperation should be deepened, prolonged and strategically prioritised.

SME

A special SME initiative was initiated in the autumn of 2014 by Vinnova and NFFP with several aims including increasing Swedish SME participation in domestic and international research programmes, and creating opportunities to be certified as suppliers for the aeronautics and aerospace industry, such as GKN and Saab. This was accomplished during the NFFP6 period in that Brogren Industries and Tooltec were certified as suppliers for the aeronautics and aerospace industry and now supply both GKN and Saab. By sharing in their experiences they have inspired many new companies to begin the process of certification.

The production arenas PTC Innovatum and Compraser Labs have led a number of focused activities consisting of thematic workshops, minor

feasibility studies and lending assistance to SMEs with research applications, for example. In total, around ten SMEs have undertaken minor "arena projects" – including focused feasibility studies and so-called gap analyses – in order to identify requirements for SMEs to move forward in certification efforts. The results after a year have exceeded expectations. For instance, HDL (manufacturer of hydro-formed metal parts) is now involved in projects to supply parts to the aviation and aerospace industry. Another result is that Flexprop (manufacturer of lightweight, carbon-fibre composites) now has products used by Saab and engages in discussion with international aircraft manufacturers regarding advanced products.

A lesson learned in the work is the importance of assisting SMEs with quick, non-bureaucratic routes to test new ideas and to create opportunities to take part in demonstrator projects in concert with major companies such as GKN and Saab. In this, Innovair and the production arenas play a pivotal role. Innovair's efforts were evaluated in February 2016 and received exemplary marks from participating SMEs, arena representatives and our state financiers.

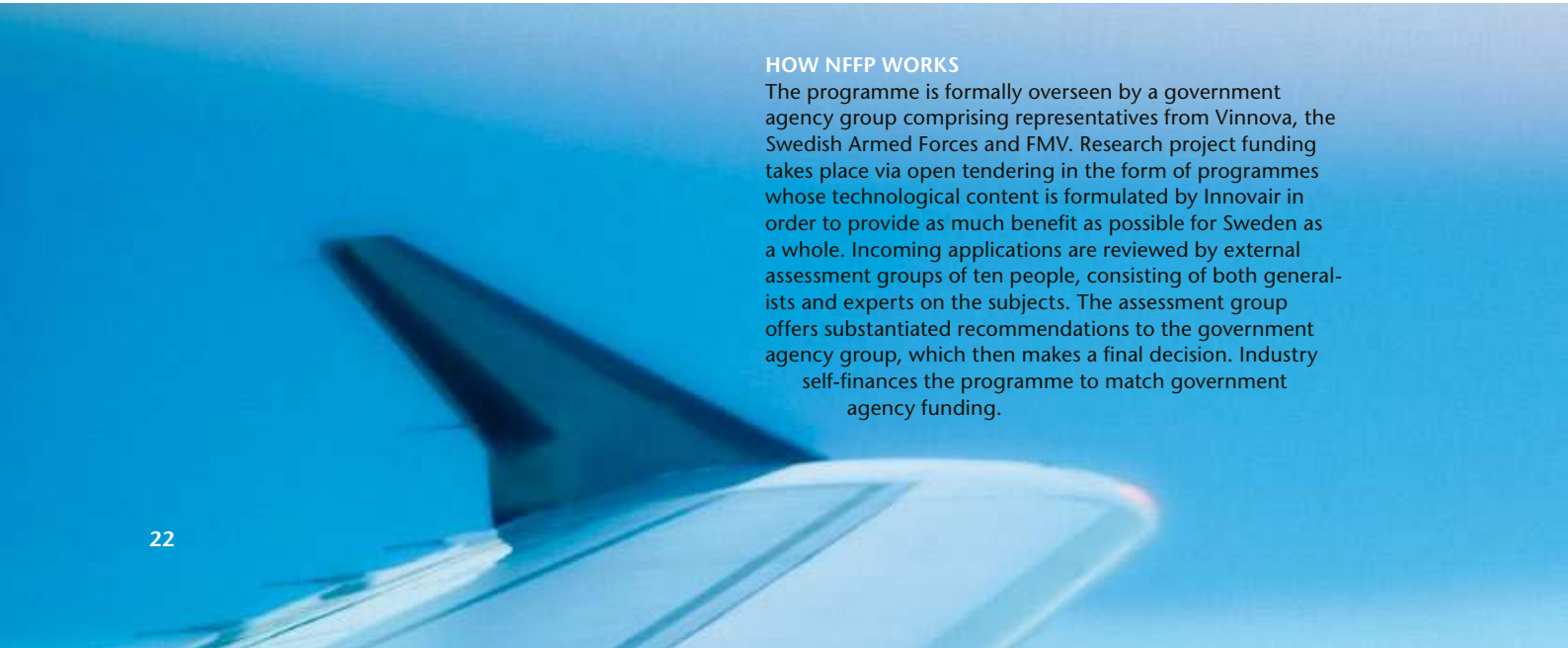
The FLUD, GF Demo and Clean Sky demonstrator projects have also played a pivotal role in developing Swedish SMEs. Demonstrators at high TRLs have proven particularly attractive to SMEs in that they entail concrete assignments which, furthermore, are closely interrelated to products, future earnings and growth for SMEs.

The natural continued investment in SMEs is logically due to the regions, the Swedish Agency for Economic and Regional Growth and participating companies allying to create an SME cluster for all aeronautics and aviation companies in the country, and that the SWE Demo and Clean Sky demonstrator projects are developing SMEs for their future growth.

Challenge: continuity

Aeronautics was designated a strategic area in the 2008 Research Bill, and the field of fighter aircraft was adjudged to be the most important area from a national security and defence perspective. Completely irrespective of other reasons, the strategic importance of aeronautics must correspond to domestic expertise within the area – at all TRLs. As this involves strategic interests – where we must retain Sweden's position in the high-tech aeronautics and aviation industry over the long-term – a substantial portion of this expertise must exist at low TRLs. *Fundamental basic skills* within aeronautics must be safeguarded and developed further.

In the EU, a record amount has been allocated to high TRL aerospace research within the Clean Sky 2 and SESAR 2020 programmes. Sweden holds a good position in these which, in the short-term, creates valuable conditions for growth and job creation. A consequence of Clean Sky and



HOW NFFP WORKS

The programme is formally overseen by a government agency group comprising representatives from Vinnova, the Swedish Armed Forces and FMV. Research project funding takes place via open tendering in the form of programmes whose technological content is formulated by Innovair in order to provide as much benefit as possible for Sweden as a whole. Incoming applications are reviewed by external assessment groups of ten people, consisting of both generalists and experts on the subjects. The assessment group offers substantiated recommendations to the government agency group, which then makes a final decision. Industry self-finances the programme to match government agency funding.

SESAR funding being allocated largely to demonstrators at relatively high TRLs is that significantly less funding is available within the EU's aeronautics research programmes at TRL 2–4.

The relatively large increase in state funding for research that occurred in Sweden over the last few years has not benefited aeronautics to a significant extent. Swedish aeronautics research funding through Vinnova has by and large remained at the same level since 2010. Military funded research has declined over time, which has resulted in drastically reduced basic aeronautics technology within FOI. In the present situation, universities cannot shoulder the responsibility and assume FOI's role without resource enhancement.

NFFP

These parallel developments at EU level and in Sweden mean that substantial aspects of research into basic aeronautics are at risk of disappearing. A continuation of the National Aeronautical Research Programme (NFFP) is a necessary prerequisite for the survival of fundamental aeronautics. The programme finances the requisite basic research at TRL 2–4 and has long served as a hub around which research efforts by academia and institutes have revolved.

Upon commencement in 1994, NFFP was primarily focused on military technology which laid the groundwork for Sweden developing its present-day unique capabilities relative to its population size. Over the last decade, military cutbacks resulted in an inverse balance of power; the present incarnation of the programme (NFFP6) is being financed by Vinnova (which is categorised under the Ministry of Enterprise and Innovation) with SEK 40 million per year and by the Swedish Armed Forces (under the Ministry of Defence) with SEK 15 million per year. The military significance is considerable: the programme is a prerequisite to the development of future fighter aircraft.

Joint financing from the Swedish Armed Forces and Vinnova, with matching funding from industry, leads to a boost in all financier investments.

NFFP6 will conclude on 30 June 2017. Programme managers from both government agencies involved are in favour of a subsequent NFFP7, of at least the same magnitude, from the second half of 2017 to 30 June 2021.

From a national standpoint, continued joint civil and military participation in NFFP is imperative, both for international credibility and optimal resource utilisation and, as we will see below, interdepartmental ownership is a vital aspect.

Project applications and project management are overseen by the industry while research is primarily conducted by academia. This results both in industrial relevance and academic excellence. This work model has been refined over the years and is working particularly well at present.

NFFP lays the necessary foundation for all aeronautical activities. A substantial portion is typically *multi use* in nature as the programme concerns very low TRLs, which means that both civil and military enterprises – as well as completely unrelated industries – receive invaluable assistance in their development. This provides a significant boost in invested funds and an ongoing opportunity for Sweden to be a leading player in the development of future fighter aircraft. It also strengthens Sweden's position as a leading partner in, and supplier to, civil aircraft and engine programmes.

EVALUATION OF NFFP

At the end of 2008, NFFP was evaluated to determine if any extension was viable. The evaluation, which comprised a comprehensive assessment of the full programme period and its effects, included document and database studies, exploratory interviews, in-depth interviews, case study interviews and participant surveys. A reference group assisted the evaluation team in the formulation of questions and in the interpretation of observations. The collective results of the evaluation were exemplary and led to the continuation of the programme, which is now in its sixth four-year phase.

IFFP

Given the changed conditions already described – increased globalisation and the consequential need for international cooperation – it is wholly apparent that NFFP, in its current form, cannot alone completely fulfil the potential for Swedish aeronautics innovation at low TRLs. The strategic investments the aeronautics area is now making in Brazil and the UK must be facilitated and strengthened from public quarters.

Not least for credibility reasons, the size of investment from the Swedish state must be in parity with the state funding expected in Brazil and the UK for these respective bilateral partnerships. A fundamental condition for Sweden to be an attractive, long-term partner in major international collaborations is, namely, in possessing qualified development expertise in the country. This expertise constitutes the combined strengths and capacities in companies, government entities, research institutes and pertinent elements of academia. Only in this way can combined and strong innovation expertise be retained from low to high TRLs. We also see that globalisation leads to both opportunities (aviation is a growing industry) and dangers (international competition being heightened), and this leads us to recognise the importance of long-term strategic partnerships with other countries – for which we need state backing.

Through bilateral collaboration programmes funded by both countries' governments and companies, considerable leverage on Swedish government investment can be sustained. With bilateral – which complement multinational – partnerships, we are able to establish a Swedish base in the partner country which

facilitates mobility and the identification of new industrial opportunities.

Just like NFFP, IFFP is proposed to be jointly financed by the Swedish Armed Forces and Vinnova, with matching funding from industry. Even here this joint funding leads to hikes in both financier investments, and the effect is doubled owing to the international impact of IFFP. And even here the programme serves as a prerequisite for development of the next generation of fighter aircraft.

The planned initiative, which fulfils established aeronautical ambitions together with these countries, is a new solution that can be evaluated and generalised in other industries in which similar long-term, bilateral strategic partnerships can be substantiated with the same – or other – countries. Initiating this programme with both a European and non-European nation will afford us valuable opportunities to develop essential skills which will be of great significance to Sweden in the future.

Demonstrator programme

In previous agendas we discussed efficiency-reducing bottlenecks such as "the valley of death" – the often underfunded gap between academic research and companies' product development of the research results – and similar. Historically, Sweden has had functional demonstrator programmes within the military sector, but now needs to safeguard this business for the future and also satisfy a long-term need for the same function in the civil sector.

Owing to the demonstrator programme we proposed in 2013 and the measures we proposed to enhance cooperation, these problems are more or less under control at present. We have contributed to a national comprehension of the problems, as well as a national will and ability to resolve them. The new SWE Demo programme is specifically intended for demonstration activities within aeronautics and aviation, but is also an important programme for the development of SMEs. There is a delicate balance between investment in research (lower TRL) and demonstrator programmes (higher TRL). The need to sustain strong and continuous demonstrator funding is imperative to address in order to avoid another "valley of death" between research and industrial operations in the innovation system.

SFP + SIP

Criticism from OECD (see **www.nriaflyg.se/oecdcriticism**) has been directed to the perceived excessive number of research-funding agencies at lower TRLs in Sweden and that these are uncoordinated, which has resulted in the absence of an overall strategy for the allocation of national research funding.

The consequence of this being that an unduly large proportion of research funding is invested in contexts that do not, on the whole, lead to the development of products, services and systems that reach the market, which means that the funding does not, in fact, contribute to actual innovation.

In conjunction with the aforementioned reasoning behind the reduction in militarily-financed research and, hence, diminished possibilities to retain basic aeronautical competence, this means that efforts must be made to ensure that a significant proportion of research conducted at low TRLs for efficiency reasons must be able to be utilised in subsequent activities at higher TRLs.

And it is precisely here an opportunity presents itself, both with regard to the ratio of funding and the efficacy of the innovation system in general. An interdepartmental initiative to create strategic research programmes (SFP) at universities and other tertiary institutions which seamlessly connect to strategic innovation programmes would mean that financing at low TRLs would, at least in part, end up where it would be of the most benefit to higher TRLs later in the innovation process. This allows the strategic innovation programmes to utilise documented competence and knowledge to increase the likelihood of fully-fledged innovation and generate more impact from previously funded research.

A financing solution of this sort can likewise be administered as a pilot case within aeronautics through the aforementioned bilateral partnerships, which would ultimately produce positive effects also for other industries and technology areas. All strategic innovation programmes are in need of facilitating conditions to function effectively, and the lack of continuity between financiers is a common bottleneck than can now be overcome.

Challenge: unanimity

Owing to the recently-signed MoU between the Västra Götaland Region/ Region Östergötland and Clean Sky, we now have – for the first time – a coherent strategy for regional, national, bilateral international and multinational investments (including EU investments) within aeronautics and aviation. The strategy covers both civil and military aeronautics as well as collaborations with other strategic innovation programmes by means of *triple use* or *multi use* projects. We also take into account environmental aspects through efforts across the TRL system.

This can be viewed as one example (of which there are several) of the need for proactive cooperative areas between the Ministries concerned. In a world becoming progressively internationalised, it is imperative that decision-makers possess an updated and synchronised view of Sweden's areas of strength and the prerequisites thereof.

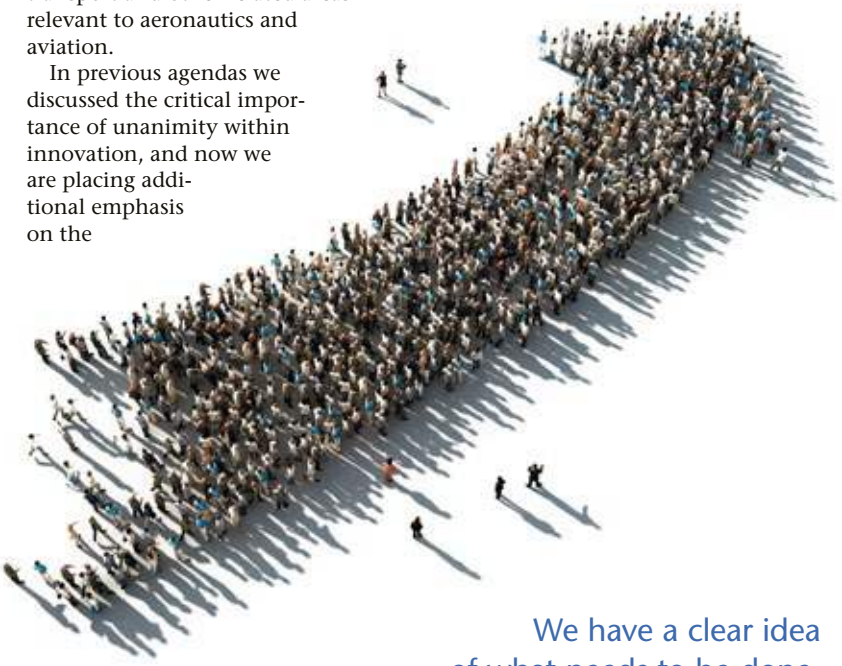
The above view of SFP and SIP synchronisation would entail an unprecedented partnership between the Swedish Ministry of Education and Research which, via the Swedish Research Council, would finance SFPs, and the Ministry of Enterprise and Innovation which, via Vinnova, would finance SIPs. NFFP and IFFP mentioned above are also examples of interdepartmental collaboration (NFFP primarily the Ministry of Enterprise and Innovation, and the Ministry of Defence; IFFP constituting the Ministry of Environment and Energy as well as the Ministry for Foreign Affairs) that generates hikes in invested tax revenue. For Swedish innovation to function effectively these cooperative areas must be created, maintained and developed.

By means of progressive interdepartmental collaboration, together with continuous well-functioning financing models, we are able to take a major step towards a complete innovation system in which conflict no longer exists between basic research and needs-driven research.

Interdepartmental cooperation of this sort can also be extended to government agencies and other contributors such as financiers within transport and other related areas relevant to aeronautics and aviation.

In previous agendas we discussed the critical importance of unanimity within innovation, and now we are placing additional emphasis on the fact that outer-lying public sector players are cooperating in *syncretic innovation* (see infobox on page 13), which means that there are no longer as many set frameworks and prerequisites as there are ministries, but where the political ownership of a technology area is collated – not within a ministry or department, but through a well-communicated and updated unanimity between stakeholders.

In this context, the advanced position of aeronautics and aviation can also function as a pilot case for the evaluation of the benefits and the potential future generalisation to other industries and technology areas.



We have a clear idea
of what needs to be done.
Which goals should we work towards to realise this?

New goals

» As a result of the changes in global conditions discussed in previous chapters, we can update our existing list of goals from previous agendas and supplement it with new goals. All new goals are aimed for 2020.

Short-term goals

1. **Research and education**
   - **a.** Swedish aeronautics and aviation research (innovation at low TRLs) is an integral part of the whole innovation system with a documented impact on industrial capabilities. ❶ ❷ ❹ ❺
   - **b.** Swedish aeronautics and aviation research has proven to be a national leader in technology dissemination to technology areas outside of proprietary technology areas. ❶ ❷ ❹ ❺
   - **c.** Attractive education for skilled jobs entices an adequate number of youths in order to satisfy the need for a nationally educated workforce within aeronautics. ❶ ❷ ❹ ❺
2. **"The valley of death"**
   - **a.** There is a political consensus that demonstrator operations are of ongoing critical significance for Swedish industry to be able to – via positioning in major international programmes – generate future contracts with qualified jobs and export revenues. ❸ ❺
   - **b.** Demonstrator programmes are in place to succeed SWE Demo which will provide Swedish players with a solid position in Clean Sky 3 and similar international programmes. ❸
3. **Swedish participation in H2020**
   The Swedish aerospace industry has attained a position equating to SEK 600 million in H2020 including Clean Sky 2 and SESAR2020, which means that Flygsverige will contribute eco-friendly technology to the benefit of future global air travellers. ❸
4. **Bilateral cooperation**
   - **a.** Sweden possesses common bilateral research tenders with at least one other country. ❷ ❹ ❺
   - **b.** Sweden is currently engaged in at least 10 ongoing collaborative projects with Brazil and England. ❷ ❸ ❹
   - **c.** Through these partnerships, Sweden has established cooperation by means of the mutual utilisation of each other's respective infrastructural resources. ❷ ❸ ❹
   - **d.** The results and experience gained in shared projects has unequivocally contributed to each country's national innovation agendas for aeronautics and aviation. ❷ ❸ ❹

1 The goal is accomplished by recommendation 1: **NFFP 7**
2 The goal is accomplished by recommendation 2: **IFFP – international aeronautics research programme**
3 The goal is accomplished by recommendation 3: **Demonstrator programme**
4 The goal is accomplished by recommendation 4: **SFP – strategic aeronautics research programme**
5 The goal is accomplished by recommendation 5: **Interdepartmental work group for aeronautics**
6 The goal is accomplished by recommendation 6: **SIP**
7 The goal is accomplished by recommendation 7: **SME**

5. **Syncretic innovation**
   The fields of aeronautics and aviation are jointly managed by the relevant ministries via an interdepartmental work group. 5
6. **SIP collaboration and technology dissemination**
   a. The various Swedish strategic innovation areas have demonstrated their combined efforts in at least five joint technological research/innovation programmes, each with more than one SIP. 3 6
   b. Owing to a triple-helix partnership between the country's aeronautics players and other technology areas, including via SIP collaborations, at least 10 triple use and multi use projects exist, with an integral part being the technology transfer between the areas. 3 6
7. **SME collaboration**
   a. Regional efforts through local programmes and additional structural funds have contributed to strengthening Sweden's national production arenas and SME competence within the fields of aeronautics and aviation. 7
   b. Swedish SMEs within aeronautics have developed new expertise via SWE Demo and regional investments, and have garnered no less than 30 % greater revenues in Clean Sky than through previous participation therein. 3 7
   c. By serving as subcontractors for GKN and Saab, Swedish SMEs within the fields of aviation and aerospace have increased their share of collective turnover within aeronautics and aviation by 20 %. 7
8. **Testing and demo facilities**
   a. Sweden's access to critical infrastructure for testing and demonstration via international cooperation is so sound that it does not constitute a barrier to innovation. 2 3 5
   b. Sweden has undeniably strengthened its investments in national production arenas where joint financing also occurs in concert with other technology areas. 5 6 7

Recommendations

» In order to confront the challenges, we recommend a number of activities that address our goals and thereby assist us in facing said challenges.

Programmes for countering internationalisation with increased competitiveness

2016:1 NFFP 7

Background: NFFP is a unique programme with both civil and military benefits. EU comparisons show that the programme is a significant factor behind Swedish success in an international context. The programme is a prerequisite for international research networks to function effectively.

We propose: that Vinnova and the Swedish Armed Forces are mandated to fund the 7th iteration of NFFP, for the years 2017–2021, at – at least – the same level as NFFP6, and with an equal proportion of co-funding from business and industry. Governance, direction, application processes and evaluation must be retained as per the current model.

First step: taken by the Ministry of Enterprise and Innovation, and Ministry of Defence in concert.

2016:2 IFFP – international aeronautics research programme

Background: Today, strategic alliances are necessary for the survival of an individual player or a national association of players. Funding programmes with international ties are lacking at low TRLs. A programme for international basic research grants Swedish players access to international testing facilities and affords opportunities for direct collaboration with leading researchers in other countries.

We propose: that Vinnova, preferably jointly with the Swedish armed Forces, is mandated to fund an international aeronautics research programme (IFFP) at TRL 2–4 in order to support bilateral partnerships with prioritised nations. IFFP is proposed to be financed by the state in the same magnitude as NFFP, and self-financed with a matching amount from the industry pursuant to regulations on state aid.

Joint financing will be effectuated with the Swedish Armed Forces, which can lead to improved collaboration, *dual use* and *triple use* gains, and the opportunity for management and governance via existing NFFP models.

The programme will be viewed as a pilot case within aeronautics and aviation as the investment is relatively low owing to the valuable international contacts within aeronautics and aviation and the fact that we are already developing subsystems for international aircraft systems. Experience will also be able to be utilised in the establishment of similar international programmes for other technology areas. The pilot case will be evaluated by independent experts.

First step: taken by the Ministry of Enterprise and Innovation, and Ministry of Defence in concert. Innovair provides input and offers to serve as facilitator in the process.

2016:3 Demonstrator programme

Background: The bridge between research and product development – the so-called "valley of death" – remains a critical point in the innovation chain.

We propose: a reinforced and steadfast continuation of the current SWE Demo programme in the form of a series of successively adapted programmes in order to position Swedish industry in international demonstrator programmes. The programmes demonstrate TRL 5–6 via participation in Clean Sky 2 and similar international programmes. This measure enables Swedish players to become evident partners to OEMs in all forthcoming aircraft and engine programmes, which will form the basis for our long-term exports – completely in line with Sweden's export strategy.

First step: Vinnova follows and evaluates SWE Demo at the intermediate stage as well as upon conclusion of the programme. The results will be used to, in consultation with Innovair, direct and strengthen continuing demonstrator programmes towards activities adjudged to provide the greatest national benefit, assuming that the desired effects of SWE Demo are reached.

2016:4 SFP – strategic aeronautics research programme

Background: Academia and institutes are required to assume the responsibility for fundamental aeronautics research no longer conducted within FOI. This responsibility must be followed by funding which, for the best possible innovation effect, should be synchronised with funding effectuated within the framework for Innovair (the aeronautics area's strategic innovation programme). Continuity between state investments results in more effective innovation, both through synchronised innovation activities and through interdepartmental cooperation.

We propose: that the Swedish Research Council (under the Swedish Ministry of Education and Research) is mandated to fund a strategic research programme (SFP) for aeronautics at TRL 1–2 with SEK 30 million per year for five years to safeguard the fundamental base in our innovation system. Direction provided by Innovair.

Half of this SEK 30 million should go to academic institutions (Chalmers, KTH, LiU) engaged in aeronautics and aviation for a coordinated investment in aeronautical education, both at an undergraduate level and postgraduate level. The other half should go to tenders in academia and institutes for research excellence provided this has an impact on aeronautics and aviation.

This will allow for the interconnection of aeronautics and aviation innovation (all the way from the idea stage to marketed product) and joint strategies between the Ministry of Education and Research and Ministry of Enterprise and Innovation in aeronautics and aviation-related matters. The investment will also have great significance for Sweden's bilateral partnerships.

The initiative will be viewed as a pilot case able to be utilised within other innovation areas in the future and which shall be evaluated by external, independent experts.

First step: taken by the Ministry of Education and Research and the Ministry of Enterprise and Innovation in concert. Innovair provides input and offers to serve as facilitator in the process.

Syncretic innovation

2016:5 Interdepartmental work group for aeronautics

Background: Aeronautics encompasses activities that fall under the Ministry of Defence (military), the Ministry of Enterprise and Innovation (industry and export), the Ministry of Education and Research (research), the Ministry of Environment and Energy (environmental impact of transport) and the Ministry for Foreign Affairs (international cooperation). Regional elements are supplementary to this. No Ministry has the requisite means or resources to manage the whole area independently. Interdepartmental cooperation is necessary to avoid local sub-optimisation with regard to the nation's collective resources.

We propose: the establishment of an interdepartmental work group for aeronautics made up of responsible officials from the Ministries concerned. This is to create a *syncretic* approach within government offices concerning aeronautics matters and to avoid "tunnel vision" and a lack of communication.

This recommendation can facilitate the implementation of other recommendations significantly.

First step: taken by the Ministry of Defence, Ministry of Enterprise and Innovation, Ministry of Education and Research, Ministry of Environment and Energy, and the Ministry for Foreign Affairs in concert.

2016:6 SIP

Background: The strategic innovation programmes require an instrument in order to guarantee the best possible conditions for synergistic effects between the programmes.

We propose: the establishment of a joint technology council for strategic innovation programmes naturally predisposed to work together. This technology council shall create joint programmes in which the contributors involved share the costs for projects of a *multi use* nature and disseminate the results to all other parties.

First step: taken by Innovair and the programme managers of the strategic innovation programmes concerned.

2016:7 SME

Background: The natural continued investment in SMEs is logically due to the regions, the Swedish Agency for Economic and Regional Growth, and participating companies allying to create an SME cluster for all aviation and aerospace companies in the country.

We propose: that the regions, the Swedish Agency for Economic and Regional Growth, and participating companies ally to create an SME cluster for all aeronautics and aviation companies in the country. This will initially comprise companies in Västra Götaland as well as the existing cluster in Östergötland which constitutes the overarching umbrella organisation Aerospace Cluster Sweden SME. In the next step, it will be proposed that SMEs from other regions in the country be invited to either establish corresponding clusters in the northern and southern regions of the country, or join the already existing networks.

First step: taken with Innovair together with the regions and the existing cluster in Östergötland.

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New challenges – and new solutions

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