

# The Final Evaluation of the Linnaeus Grant

A ten year program for establishing  
Centres of Excellence

Linnaeus  
Grant

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Centres of Excellence

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## Foreword

In 2005, the Swedish Research Council and Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, were commissioned by the Government to support the development of Centres of Excellence (CoE), known as Linnaeus centres, at Swedish higher education institutions (HEIs). The Government's research bill "Research for a better future" (Govt. Bill 2004/05:80) announced the grant, and the remit was to strengthen the ability of Swedish HEIs to prioritise and profile Swedish research to be internationally competitive at the forefront by building strong research environments. The Swedish Research Council announced the grant in two separate calls in 2005 and 2007, and awarded funding to 20 CoE for ten years at each call, with a maximum grant of 10 million SEK per year.

The main purpose of the final evaluation of the Linnaeus grant was to provide feedback and learning to the Government, the research funding bodies and the HEIs regarding the experience and effects of the Linnaeus grant.

The evaluation has been performed by an international panel who has summarized their findings in this report. Their assessments are based on material from the Linnaeus centres and the Swedish research council, and finally on hearings they performed with the HEIs management and representatives from the Linnaeus centres.

The main conclusions from the panel are that the Linnaeus program has been a successful program for strengthening Swedish research, as well as having an important role in making the Swedish universities more internationally visible. The panel recommends a new national program for Centres of Excellence at the Swedish HEIs, with long-term flexible funding for basic research with a bottom up approach.

The Swedish Research Council and Formas would like to thank the two chairmen Professor Jürgen Mlynek and Professor Marja Makarow and the rest of the international panel for an excellent work that will be of great value to the Swedish government, the Higher Educational Institutions and the research councils to strengthen Swedish research.

Sven Stafström  
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Swedish research Council

Ingrid Pettersson  
*Director General*  
Formas

## Sammanfattning

Vetenskapsrådet och Formas fick genom forskningspropositionen 2004/05:80 i uppdrag av regeringen att finansiera en satsning på att utveckla starka forskningsmiljöer, så kallade Centres of Excellence, (CoE) vid svenska lärosäten (HEI). Vetenskapsrådet genomförde två utlysningar under 2005 och 2007 och beviljade bidrag till totalt 40 Linnécenter bland drygt 200 ansökningar. Varje miljö fick mellan 5 och 10 miljoner kronor per år under 10 år.

Linnéstödet har utvärderats vid två tillfällen för varje utlysning, första gången efter två år och andra gången efter fem år. Den slutliga utvärderingen av Linnéstödet, som redovisas här, har genomförts samlat för alla Linnécenter. Syftet med utvärderingen är att återkoppla och dela kunskapen om erfarenheter och effekter av satsningen med regeringen, forskningsfinansiärerna och lärosätena.

### Panelens slutsatser och bedömningar

Panelen menar att även om finansieringsnivån för enskilda Linnécenter var relativt låg jämfört med andra motsvarande internationella program, så medförde Linnéstödets långsiktighet och flexibilitet en förbättring av de deltagande svenska lärosätenas nationella och internationella konkurrenskraft och synlighet.

Programmet har uppenbarligen stimulerat en långsiktig förändring av hur majoriteten av lärosäten och enskilda forskare samarbetar internt, vilket har lett till en mer strategisk planering och förbättrad synergi inom de enskilda institutionerna.

Flera Linnécenter har genomfört forskning som lett till nya genombrott och de har också varit framgångsrika i att knyta till sig extern finansiering från bland annat Europeiska forskningsrådet, ERC.

Linnébidraget har bidragit till en framgångsrik internationalisering av den svenska forskarbasen. De flesta Linnécentren har rekryterat doktorander och postdoktorer från utlandet. Flera av de rekryterade har blivit akademiska ledare vid svenska lärosäten, men panelen mötte också framgångsrika utländska unga forskare, vars karriärmöjligheter efter nedläggningen av Linnécentret tycktes ha stagnerat i det svenska akademiska karriärsystemet.

Panelen anser att Linnéstödets 10-åriga finansiering har möjliggjort forskning med hög risk/stora möjligheter, som också har lett till en del banbrytande upptäckter, på ett annat sätt än vad projektfinsiering riktad till individuella forskare med finansiering under 3–4 år normalt gör.

Linnécentren har, även om de i många fall placerats inom enskilda fakulteter eller institutioner på respektive lärosäte, möjliggjort tvärvetenskaplig forskningsverksamhet. Även om Linnécentren i stor utsträckning samverkade och samarbetade med forskare utanför deras center, var interaktion mellan Linnécenter inom enskilda lärosäten och mellan lärosätena sällsynta.

Panelen anser att merparten av lärosätena inte har utnyttjat möjligheten att använda sina Linnécenter och Linnésatsningen i sin marknadsföring. Panelen ansåg att detta var en förlorad möjlighet att i internationella sammanhang lyfta fram svensk

forskningspolicy och finansieringsinstrument som etablerat ett framgångsrikt excellensprogram med en ovanligt lång finansieringstid på tio år, vilket möjliggjort genombrottsforskning.

De flesta av Linnécentren utnyttjade framgångsrikt Linnéstödet för att attrahera internationella doktorander och postdoktorer till sina forskningsmiljöer. Kulturen främjade samarbete och kunskapsutbyte genom seminarier, workshoppar och internationella möten. Den parallella finansieringen av en forskarskola för vissa Linnécenter i första utlysningen visade sig vara oerhört viktig.

Genom sin fokusering på grundläggande forskning, flexibilitet och långsiktighet, möjliggjorde Linnéstödet etableringen av framgångsrika forskningsmiljöer. Centrerna har skapat banbrytande forskning, utbildat en högkvalificerad ny generation av forskare och utvecklat hållbara forskningsmiljöer som har stärkt Sveriges ställning som en av de ledande forskningsnationerna i Europa.

### **Lärdomar från genomförandet av Linnéprogrammet**

Panelen gjorde följande iakttagelser som kan summeras under lärdomar:

- Programmet har inte riktigt bidragit till att profilera lärosätena. Här var de positiva effekterna mest uppenbara vid de mindre lärosätena. De allra flesta lärosäten ville inte profilera sig i enlighet med sina starka forskningsområden. Därför ingår sällan Linnécentrernas forskningsområden i lärosätenas forskningsstrategi, om en sådan strategi existerar. Som en konsekvens av detta har Linnécentrumen endast i fåtal fall förändrat processer och forskningskultur på lärosätet. Att öka Linnécentrens synlighet lämnades till stor del till centrumen själva.
- Den nödvändiga medfinansieringen från lärosätena var inte tydligt definierad. Därför fick Linnécentren ofta in-kind bidrag eller bara overhead-påslaget som följde med Linnéstödet, i stället för finansiellt stöd från det egna lärosätet.
- Samarbeten mellan olika lärosäten var ovanligt när det gäller Linnésatsningen. Det fanns ingen övergripande strategi för de enskilda lärosätenas räkning, och det verkar inte heller ha gjorts någon gemensam insats för att utbyta erfarenheter och goda exempel mellan Linnécenter eller lärosäten.

### **Panelens rekommendationer:**

Panelen rekommenderar att ett nytt Center of Excellence-program (CoE-program) inrättas som behåller de beprövade elementen från den tidigare satsningen, tar hänsyn till lärdomarna och inkluderar nya element för att förstärka programmet ytterligare. Det slutliga målet med det nya CoE-programmet bör vara att ytterligare stärka svenska lärosäten och det svenska forskningssystemet som helhet i en allt mer

konkurrensutsatt värld. Om Sverige vill förbli en av innovationsledarna i Europa och på global nivå är excellens inom grundforskning en absolut förutsättning.

Panelen har haft omfattande diskussioner om vilka delar av Linnéprogrammet som bör upprätthållas i ett nytt CoE-program och vilka element som bör läggas till.

Panelens rekommendationer kan sammanfattas under följande punkter:

- **Excellens:** Konstaterad excellens inom grundläggande forskning måste vara urvalsgrunden för centren. Projekten måste vara banbrytande och djärva, eventuellt också inom områden som inte tillhör de etablerade. En kritisk massa av starka forskningsledare bör vara involverade från början samt med tydlig tvärvetenskaplig inriktning.
- **Lång varaktighet:** Den långa bidragstiden på 10 år är en hörnsten i CoE-program. Den måste upprätthållas för att ge ett långsiktigt perspektiv och chans till banbrytande forskning. Kvalitetsuppföljning bör finnas på plats från början, men vara effektivt utformad för att minimera arbetsbelastning på centren.
- **Stor flexibilitet:** Flexibel användning av det finansiella stödet för centrumen är avgörande. Det måste vara CoE själv som avgör vid varje tillfälle om stödet ska användas till att rekrytera forskare, infrastrukturer, workshoppar, löner eller utrustning.
- **Lämplig finansiering:** Finansieringsbeloppet bör bero på antalet forskningsledare som är involverade i centret. Om medfinansiering från lärosätena alls ska krävas, behöver detta vara tydligt definierat. Hur som helst bör det ställas krav på någon form av engagemang från lärosätena.
- **Öppna utlysningar:** Excellens inom forskning bör vara det främsta kriteriet för urval. Utlysningarna bör därför vara tematiskt öppna och inte begränsade till vissa ämnen. I ett nytt CoE-program bör det övervägas att ha återkommande utlysningar, dvs. en utlysning vartannat år eller vart tredje år, för att upprätthålla förnyelsen på lärosätena. Gemensamma center mellan lärosäten bör också vara möjligt.

## Executive Summary

In 2005, the Swedish Research Council and Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, were commissioned by the Government to support the development of Centres of Excellence (CoE), known as Linnaeus centres, at Swedish higher education institutions (HEIs). The Swedish Research Council announced the grant in two separate calls in 2005 and 2007, and awarded funding to 20 CoE for ten years at each call, with a maximum grant of 10 million SEK per year during the programme period.

The main purpose of the Final Evaluation of the Linnaeus grant is to provide feedback and learning to the Government, the research funding bodies and the HEIs regarding the experience and effects of the Linnaeus grant.

### **The panel's assessment**

The panel concludes that although the level of funding obtained within the Linnaeus programme for individual centres was relatively small compared with other external funding programmes, the long-term and flexible nature of the funding provided an important impetus to the enhancement of the national and international competitiveness and visibility of the Swedish HEIs that participated in the programme. The programme has clearly stimulated a long-term change in the way that the majority of HEIs and individual researchers approach internal collaboration, leading to a more strategic planning and enhanced synergy within the individual institutions.

Several Linnaeus centres have championed with break-through findings and have succeeded in highly competitive international calls, such as the European Research Council ERC.

The Linnaeus grant has been instrumental and very successful in internationalization of the Swedish researcher base. Most centres were able to recruit PhD candidates and post-doctoral researchers from abroad. Several of the recruits have become academic leaders in Swedish universities, though the Panel also encountered international successful young recruits, whose career opportunities after the closure of their Linnaeus Centre appeared to have been stagnated in the Swedish academic career system.

Traditional project funding targeted to individual principle investigators usually is provided for 3-4 years. The short duration of such grants guide the awardees to avoid risky bold research topics. The 10-year duration of the Linnaeus grant has allowed high gain/high risk research that is the enabler of ground-breaking discoveries.

The Linnaeus centres, though in many cases placed within individual faculties or departments in their host universities, have enabled inter-disciplinary research activities and crossing borders of research fields and the university's internal structures. Though the centres interacted and collaborated extensively with

researchers beyond their centre, interactions between the Linnaeus centres within single universities and between universities were rare.

Most of the host universities as institutions have not used their Linnaeus centres success for branding. The universities' leadership had entrusted the communication of the scientific output to individual researchers of the centres. The Panel felt this was a lost opportunity to highlight internationally Sweden's research policy and funding instruments that enabled the establishment of a successful excellence programme with an unusually long term of 10 years enabling break through research.

Linnaeus recruitment was strongly international. Most of the centres successfully utilized the Linnaeus funding to attract internationally excellent PhD and post-doctoral students, fostering a culture of collaboration and knowledge exchange through seminars, workshops and international colloquia. In this respect the parallel funding of a research school for some Linnaeus centres in the first call was extremely important.

The Linnaeus programme, due to its focus on fundamental research, flexibility what concerns the choices on where to target the money, and its ten years duration, has enabled the building of successful research environments. The centres have achieved breakthrough research, trained a highly-skilled new generation of researchers and developed sustainable research environments that have strengthened the position of Sweden as one of the leading research nations in Europe.

### **Lessons learned**

The panel made the following observations that could be summarized under lessons learned:

- The programme has not really contributed to profiling the HEIs. Here the positive impact was most apparent at the smaller institutions. The vast majority of the universities do not wish to profile themselves according to their strong research fields. Therefore the Linnaeus Centres research field do not feature in those universities research strategy, should a research strategy even exist. As a consequence only in few cases were the Linnaeus Centre transformative in terms of processes and culture of research. Increasing the visibility was largely left to the centres themselves.
- The required co-funding from the HEIs was not clearly defined. Therefore universities instead of cash contributions often used in-kind contributions to support the Linnaeus Centres or just the overhead that came with the Linnaeus funding.
- Only few cross-institutional collaborations took place, most often the Linnaeus centres were based in one HEI. Activities between centres of different host universities were rare. There was no over-arching strategy apparent on behalf of the individual HEIs, nor does there seem to have been any concerted effort to exchange experiences and examples of best practice between the centres or the HEIs.

### **The panel's recommendations**

The panel clearly recommends the establishing of a new Centre of Excellence programme that keeps the proven elements, reflects the lessons learned and incorporates new elements to make the programme even more compelling. The ultimate goal of this new CoE Programme is to further strengthen the Swedish HEI and the science system as a whole in a world of increased competitiveness. If Sweden wants to remain one of the innovation leaders in Europe and at the global scale, excellence in basic research is an absolute prerequisite.

The panel has extensively discussed which elements of the Linnaeus Programme should be maintained in a new CoE Programme and which elements should be added.

The panel's recommendations can be summarized under the following key headings:

- Proven excellence: the CoEs have to be based on proven excellence in fundamental research. The projects must be breakthrough oriented and bold, possibly in emerging fields not serving the established “silos”. A critical mass of PIs should be involved from the very beginning with interdisciplinary being emphasised.
- Long Duration: the long term duration of 10 years is a central cornerstone of the CoE initiative. It must be maintained to give a clear perspective for ground-breaking research with a long breath. Quality monitoring should be present but lean.
- Large Flexibility: the flexible use of the funding is essential. Whether this will be used for recruiting, infrastructure or workshops, salaries or equipment must be at the disposition of the CoE and can change over the time.
- Appropriate Funding: the amount of funding should depend on the number of PIs involved in a CoE.. If required at all, the co-funding from the HEIs should be clearly defined. In any case a clear commitment of support from the HEI should be a condition.
- Open calls: Excellence in research should be the number 1 criteria for selection. The calls should therefore be thematically open and not restricted to certain topics. In a new CoE initiative it should be considered to have rolling calls, i.e. a call every 2-3 years to keep the momentum of renewal in the HEIs going. Interuniversity centres should be allowed too.

## The Linnaeus centres

Abbreviation	HEI	Call	Centre	Subject area	Description
CTH	Chalmers University of Technology	2006	LinneQS	N	Engineered quantum systems
		2008	SUPRA	N	Bioinspired Supramolecular Function and Design
GU	University of Gothenburg	2006	LinCS	HS	Learning, Interaction and Mediated communication in contemporary Society
		2008	CeMEB	N	Adaptation to changing marine environments (ACME) - an integrated research program in marine evolutionary biology
KI	Karolinska Institutet	2006	DBRM	M	Developmental Biology for Regenerative Medicine
			STARGET	M	Cancer research, studies of the diagnostic, prognostic and therapeutic potential of mesenchymal cells of the tumor
		2008	CERIC	M	Research on Inflammation and Cardiovascular Disease
			CrisP	M	Individualized prediction and prevention of breast and prostate cancer
			THRM	M	The Human Regenerative Map - Stem cell research and regenerative medicine
KTH	Royal Institute of Technology	2006	ACCESS	E	Autonomic Complex Communication nEtworks, Signals, and Systems
			FLOW	E	A blueprint for future flow research - utilizing new computational possibilities with new key physical experiments, to outline a blueprint for future flow research
		2008	ADOPT	E	Advanced optics and photonics
LIU	Linköping University	2006	Lili-NFM	E	Linköping Linnaeus Initiative for Novel Functional Materials
		2008	CADICS	E	Control, Autonomy, and Decision-making in Complex Systems
			HEAD	HS	Cognitive Hearing Science
LU	Lund University	2006	CED	HS	Economic Demography
			HEMATO-Linne	M	To study the regulation of normal and leukemic hematopoietic stem cells (HSCs) and blood lineage
			LLC	N	Exploring and Controlling the States of Matter with Light - Multidisciplinary Laser Spectroscopy within the Lund Laser
			LUCIE	HS	Innovation, Entrepreneurship and Knowledge Creation: Dynamics in Globalising Learning Economies
			LUDC	M	Dissection of the genetic and metabolic complexity of diabetes and its complications
			NanoQE	E	Nanoscience and Quantum Engineering
			NRC	M	Neuroscience, nano- and microtechnology and biotechnology
		2008	OMM	N	Organizing Molecular Matter - intermolecular interactions and how they promote the organization of molecular matter
			Bagadilico	M	A joint initiative for the development of novel therapies for basal ganglia disorders
			CAnMove	N	Evolution and Ecology of Animal Mobility
			CCL	HS	Cognition, Communication and learning
			LCCC	E	Controlling Complex Engineering Systems (CoCos)
			LUCCI	N	Studies of Carbon Cycle and Climate Interaction
SLU	Swedish University of Agricultural Sciences	2006	ICE3	N	Insect Chemical Ecology, Ethology and Evolution
SU	Stockholm University	2006	BBCC	N	Climate evolution, variability and sensitivity
		2008	OKC	N	The CosmoParticle Collaboration - using the combined skills of particle physicists, astrophysicists and cosmologists to adress fundamental questions concerning dark matter, dark energy and extreme objects in the universe
			SPaDe	HS	Social Policy and Family Dynamics in Europe
UmU	Umeå University	2006	ALC	HS	Ageing and Living Conditions
		2008	UCMR	M	Microbial Research - Discovery of novel antimicrobials to combat disease in the future
UU	Uppsala University	2006	URRC	N	RNA RESEARCH - RNA Biology/Chemistry
		2008	IMPACT	HS	The Impact of Religion: Challenges for Society, Law and Democracy
			UCEG	N	The Genomics of Phenotypic Diversity in Natural Population
			UPMARC	E	Programming for Multicore Architectures

## Best practice – top three universities on capacity building and top three Linnaeus centres for research performance and societal relevance

### Capacity building at the Universities

The panel was asked to nominate the top three universities that can serve as good examples for both hosting CoE's but also for using the investment to further their international competitiveness. The result is summarized in the table below.

*Capacity building – top three universities*

Chalmers university of technology (CTH)	
University of Gothenburg (GU)	
Karolinska institutet (KI)	
Linköping university (LiU)	LiU
Lund university (LU)	
Royal institute of technology (KTH)	
Swedish university of agricultural sciences (SLU)	
Stockholm university (SU)	
Umeå university (UmU)	UmU
Uppsala university (UU)	UU

The panels reasoning and motives for the nominated universities can be found in chapter 1.

### Research Performance of the Linnaeus centres

The panel was divided into four subpanels, representing their respective area of research:

1. Natural Sciences
2. Engineering Sciences
3. Medical Sciences
4. Humanities and Social Sciences

The subpanels was asked to assess the research performance of the Linnaeus centres, within their respective fields, and to nominate the centres that were seen as the top three. The result is summarized in the table below.

	<i>Research performance – top three centres</i>			
	<b>Natural Sciences</b>	<b>Engineering Sciences</b>	<b>Medical Sciences</b>	<b>Humanities and Social Sciences</b>
Chalmers university of technology (CTH)	LinnéQS			
University of Gothenburg (GU)				LinCS
Karolinska institutet (KI)			CERIC	
Linköping university (LiU)				HEAD
Lund university (LU)		NanoQE	LUDC	
Royal institute of technology (KTH)		ACCESS, FLOW		
Swedish university of agricultural sciences (SLU)	ICE3			
Stockholm university (SU)	OKC			SPaDE
Umeå university (UmU)			UCMR	
Uppsala university (UU)				

The subpanels reasoning and motives for the nominated Linnaeus centres can be found in chapter 2.

### Societal relevance of the research at Linnaeus centres

The subpanels was also asked to assess the societal relevance of the research at the Linnaeus centres, within their respective fields, and to nominate the centres that were seen as the top three. The result is summarized in the table below.

	<i>Societal relevance – Top three centres</i>			
	<b>Natural Sciences</b>	<b>Engineering Sciences</b>	<b>Medical Sciences</b>	<b>Humanities and Social Sciences</b>
Chalmers University of Technology (CTH)	SUPRA			
University of Gothenburg (GU)	CeMEB			LinCS
Karolinska Institutet (KI)			CrisP	
Linköping University (LiU)				HEAD
Lund University (LU)	LLC	NanoQE	LUDC	
Royal Institute of Technology (KTH)		ACCESS		
Swedish University of Agricultural Sciences (SLU)				
Stockholm University (SU)				SPaDE
Umeå University (UmU)			UCMR	
Uppsala University (UU)		UPMARC		

The subpanels reasoning and motives for the nominated Linnaeus centres can be found in chapter 3.

## Evaluation assignment and data

### Evaluation assignment

The Linnaeus centres have been evaluated twice before, the first evaluation after two years focusing on the organizational set-up of the centre, and the second evaluation after five years focusing more on the scientific quality of the centres research and research production. This final evaluation focuses on the effects of the Linnaeus program and is performed after the ten-year grant period.

To perform the evaluation an extensive set of reports were produced by the Swedish Research Council. These reports are based on data provided by the centres and contain information necessary for conducting the evaluation and served as a base for the evaluation panel when they performed the hearings.

An international expert panel consisting of 13 members was assigned for the final evaluation of the Linnaeus grant. The evaluation was carried out in two steps by the panel. The first step consisted of a pre-evaluation based on collected data, and the second step of hearings with personnel from the involved HEIs and their Linnaeus centres.

### Four evaluation questions

The pre-evaluation was organized around answering evaluation questions 1-3. The provided data were the base for the assessments and was specific for each assignment and complemented by the panels interviews with the HEIs and Linnaeus Centres, for detailed instructions, see appendix 3.

2. Has the Linnaeus grant led to the establishment of sustainable research environments, i.e. CoEs, with internationally competitive research?
3. Have the HEIs, through the Linnaeus grant and its terms of conditions, strengthened their ability to prioritise and profile their research for increasing their international competitiveness?
4. Has the establishment of Linnaeus centres and their research efforts led to research that has societal relevance?
5. Has the establishment of the Linnaeus Centres helped to strengthen the research system's ability to achieve the Government's goal of promoting Sweden as a research nation internationally?

### Data provided by the Linnaeus centres

The centres were asked to send in publication lists and top publications, for detailed instructions to the centres on self-reporting, see Appendix 4 and 5. The publication lists were subjected to bibliometric analysis and the analyses were presented in a bibliometric report to the panel. The top publications were subjected to peer review by external experts and data was summarized in a peer review report to the panel.

The centres were also asked to compile one scientific case and one societal impact case, instructions for them on how to write them can be found on Appendix 6 and 7.

In addition, the centres were asked to send in data on financing and personnel information as well as an organisational chart.

Finally, the centres, and the management of the HEI were subjected to interviews and surveys performed by personnel from the Swedish research council.

## Data provided to the panel

The following data and reports were available for the panel to use in the evaluation:

6. The expert panel's interviews with the HEIs and Linnaeus Centres
7. Bibliometric analysis – volume of publications, citation analysis, network maps
8. Peer review of publications by external experts
9. Scientific case study provided by the Linnaeus centre
10. Societal case study provided by the Linnaeus centre
11. Interview data compiled for each HEI (Interview report)
12. Focus group interviews compiled for each HEI
13. Data on financing and personnel for each centre
14. Organisational chart
15. Survey of researchers and external advisors (Survey report)
16. Background information of Linnaeus centre from previous evaluations

# 1. Capacity building

## 1.1 Introduction

The questions posed by the evaluation panel regarding the extent to which the creation of Linnaeus Centres has succeeded in building "capacity" in Swedish HEIs were very revealing. At one level, there was near unanimity about the Linnaeus Centres having the great merit of flexible funding and the relative security of lasting for 10 years. There was also a recognition that they came at a time when the classical University model of Departments that were pretty much a law unto themselves - academic silos - was breaking down in favour of much greater interdisciplinarity. The Linnaeus program was both a reflection of that radical change in culture across many European Universities (not just in Sweden) and a catalyst for its progression.

However, at another level, there was also great loyalty towards the idea of a "bottom-up" approach to choosing research questions and academic organisation. Allowing the University administration to impose a research strategy was looked upon as being at best inappropriate.

As described below across the Centres, numerous examples are offered as to why the reality of this academic liberty was so important for success.

In what follows, we consider the various HEIs that were successful in securing funding and the Centres that were supported. More precisely, the sub-chapters generally start with a short description of the Linnaeus Centres at the HEI and then present the assessment of the Universities regarding capacity building under various aspects.

The first subsection of Chapter 1 for each University includes an assessment of the capacity building in establishing Centres of Excellence at the Universities and covers evaluation criteria including

- Centre identity and organisation,
- management and leadership,
- knowledge transfer within the Centre,
- collaboration and communication and, most importantly,
- the added value of the CoE.

The second subsection tries to give a general assessment on how the capacity building of establishing Centres of Excellence has been supported and secured by the University management and how the University has used the investment for profiling the research investments at the University and increasing their international visibility.

Here the main evaluation criteria were

- General knowledge and understanding of the concept of CoE for enhancing research quality and building strong research environments with critical mass in HEI
- Management of CoE investment for increasing the attractiveness of the HEI
- Profiling of research portfolio at HEI and International visibility of HEI.

The panel tried to address all these issues in hearings with the HEIs, with an extended questions and answers session, giving the representatives from the HEI the possibility to bring up all their experiences from the Linnaeus program, especially under the aspects of lessons learned. To the surprise of the panel only two HEI were represented by their presidents. In addition, many members of the university administration in the hearings were not in their post during the active period of the Linnaeus program and therefore could not testify with their own first-hand experience. This of course is also due to the fact that the present evaluation took place a number of years after the funding for the Linnaeus Centres ended. Nevertheless, the panel felt able to come to some judgement on the usefulness of the Linnaeus program, based partly on the extensive material provided in advance for the pre-evaluation process.

## 1.2 Capacity building at Chalmers University of Technology (CTH)

### **Linnaeus centres at CTH**

CTH had two Linnaeus centres: Linnaeus Centre on Engineering Quantum Systems (LinneQS) with an associated Research School from the 2006 call and the Centre for Bio-inspired Supramolecular function and design (SUPRA) from the 2008 call.

Both Centres were formed through a bottom-up process and submitted their applications after an internal competition at CTH. The Centres were able to create a clear identity, which has continued after the Linnaeus funding period.

There has been a significant and very successful evolution of both Centres. They formed a new nanocentre with Strategic Research Area (SRA)<sup>1</sup> funding and had central roles in the establishment of the Wallenberg Centre for Quantum Technology and the European Graphene Flagship. The understanding is that this evolution would not have happened without these Linnaeus centres. While the Centres no longer exist formally, they continue in these new environments. Consequently, close-down has not been a problem.

Both Centres, as well as the HEI leadership, emphasize the important added value of the Linnaeus funding. In addition to the evolution mentioned above, the scientists in the centres have been successful in attracting other external funding, e.g. ERC grants.

The CoE management and leadership have been lean and efficient. The HEI management seems to have left the management issues mostly to the Centres.

The CoEs recruited mostly PhD students and post-doctoral researchers, whereas long-term positions were handled at the Departmental level. It is evident that the Linnaeus Centres have led to major changes in the recruitment system. This has become more internationally oriented compared to earlier in-house recruitments,

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<sup>1</sup> SRA was an investment in strategic research areas launched in the 2008 Government Bill 'A Boost to Research and Innovation' (prop. 2008/09:50) and was carried out by the Swedish Research Council, Formas, Vinnova and the Swedish Energy Agency on behalf of the government. The initiative included 20 strategic research areas (SRAs) with 43 research environments at 11 host universities and were funded with 5270 MSEK during 2010-2014.

e.g., including better start-up packages and more emphasis on gender issues. Nevertheless, progress toward a more balanced gender division has been quite modest.

For knowledge transfer the Centres created two important tools that continue running: Linnaeus colloquia and Linnaeus coffee meetings. Also, the informal mentoring of new leaders has turned out to be successful.

Continuous renewal and its importance are clear from the evolution from the original structure to the presently much larger and stronger environment.

### **CTH ability to host and develop CoEs**

That the two Centres have performed so well and been able to renew and establish impressive follow-on structures is an indication that there is a good understanding at CTH of what a CoE means. At the same time, CTH advised that they have 40 centres of very different sizes and, in this context, it remains unclear what a “centre” really means. The lack of institutional memory of the early phases of the Linnaeus Centres during the interview made it difficult to assess the present understanding of Centres and their needs at the HEI level.

The reporting for the final evaluation also reveals problems within the institutional management of the CoE investment. It is evident that the Linnaeus funding has led to important achievements, which the HEI is not reporting. In fact, it seems that the HEI management has left these as the responsibility of the Centres. LinneQS claims that reporting the graphene flagship would have disrupted the reporting system. A functional reporting system should not have problems reporting all results.

The Linnaeus centres at CTH led to renewal and to profiling at the national level in nanoscience. Here centres at CTH and LU complemented each other. The networking between different universities seems to work well, particularly within areas of Wallenberg funding.

Research and its visibility were already at a high international level before the Linnaeus centres were established but the Linnaeus funding gave more possibilities to develop international visibility. This has also been positive for diversity development.

The recommendations for the future included the need for long-term funding, open calls, perhaps smaller numbers of PIs, clear requirements for cash co-funding, and flexibility to build joint centres nationally. It was also warned against letting this type of funding lead to uncontrolled growth of the universities.

## **1.3 Capacity building at Gothenburg University (GU)**

### **Linnaeus centres at GU**

Gothenburg University is a comprehensive university with a broad range of disciplines. Within the Linnaeus Program, the University had two Linnaeus Centres funded, one in the context of Human Social Science - the Centre for Learning, Interaction, and Mediated Communication in Contemporary Society (LinCS), and the other in the context of Natural Science, the Centre for Marine Evolutionary Biology (CeMEB).

Both Linnaeus Centres were well appreciated by their members and advisers, as can be seen in the surveys in which they got good ratings for their research outputs, the relevance of the Centres for the individual research performance of their members, and in other ways. In both Centres, one finds quite a good level of international cooperation. After the end of the Linnaeus Program one grouping still exists as a Centre whereas the other continues its work in a new constellation.

The Centre for Learning, Interaction, and Mediated Communication in Contemporary Society successfully managed an interdisciplinary scope including educational science, computer science, and library science. LinCS also included a research school. Collaboration was spread across nearly the whole of Europe and even beyond. During the program, the centre was successful in obtaining substantial additional funding from the Knowledge Foundation and the Wallenberg Foundation.

The Centre for Marine Evolutionary Biology hosted by the Department of Marine Ecology and the Faculty of Science included members from three Departments, and it successfully integrated staff at marine laboratories outside Gothenburg (Tjärnö and Kristineberg). The organizational strategy was open to bottom-up ideas, cooperated internationally in research projects and involved the advisory board with regular meetings each term. This Centre had a good balance between basic and applied science and was quite successful in publishing its results.

In both Centres there was a strong lead over the whole period or, at least, extended periods and even continuing after the end of the Linnaeus funding. Regular meetings of members and of the International Advisory Board took place each term. The strong lead and the reputation of the leading persons were substantial components in establishing international links and the level of international cooperation.

Both Centres were successful in attracting qualified members within Sweden and from abroad, both as members of the Centre and as members of the Advisory Board.

### **GU ability to host and develop CoEs**

From the perspective of this large university as a whole, the two Linnaeus Centres are not playing a crucial role for the profile of the University, as there is an interest on the part of the University administration for Gothenburg being seen as a comprehensive university with a broad range of disciplines. However, that said, the representatives of the University made clear their strong interest in supporting their two Linnaeus Centres and the evidence supports this. This led to a development, for each of the Centres, of gaining substantial recognition as national centres of excellence within their respective science communities. Looking to the future, the view of the Vice-Chancellor and that of the Centres is that there is a strong interest in having a continued program like the Linnaeus programme or a similar follow-up adapted to today's situation. This should maintain the long duration (like ten years), the flexibility, the bottom-up nature of the chosen topics, fewer Centres with a little bit more money per Centre, less Principal investigators, and still an openness for high risk research. The Gothenburg group mentioned additionally a strong interest in collaborative centres between universities.

## 1.4 Capacity building at Karolinska Insitutet (KI)

### **Linnaeus centres at KI**

KI has five Linnaeus Centres, all in the medical field: developmental biology and regenerative medicine (DBRM), diagnostic, prognostic and therapeutic potential of mesenchymal tumour cells (STARGET), inflammation and cardiovascular disease (CERIC), prediction and prevention of breast and prostate cancer (CrisP), stem cell research and regenerative medicine (THRM). The centres vary markedly in terms of size, funding, operational practices and even scientific output. In regard to the overall university context, the Linnaeus Centres were clearly more compensatory than transformative of the traditional Faculty and Departmental structure of the university. Nonetheless, measured by top 10 percent and top 1 percent citations, the Linnaeus Centres at KI have been about twice as successful as the rest of KI.

CERIC focuses on chronic inflammation, the pathobiological process that links inflammatory disorders such as multiple sclerosis, rheumatoid arthritis and psoriasis with atherosclerotic cardiovascular disease. The CERIC research team identified mechanisms of chronic inflammation leading to cardiovascular disease, also novel therapy targets and investigated the effects of targeted therapies against CID and CVD, examined risk factors in breast and prostate cancer, developed new genetic prognostic markers in breast and prostate cancer as well as risk and progression prediction models in breast and prostate cancer. Overall the aim was to establish the field of “Translational Epidemiology” using individual prediction models and implement them in large-scale targeted prevention programs.

CrisP, the Linnaeus Centre for Prevention of Breast and Prostate Cancer, is one of the many large research projects organised by the Department of Medical Epidemiology and Biostatistics (MEB) in Karolinska Institutet (KI). The overarching goal is to put translational medicine for breast and prostate cancer into practice. CrisP is a matrix organisation and has a steering committee, an executive group, project managers and a scientific director. There are twelve groups from seven different departments participating in CrisP. Even beyond KI CrisP organizes large research networks. This provided the unique opportunity to conduct a longitudinal, population-based study of large cohorts (involving 75000 women for breast cancer and 58000 men for prostate cancer). The aim is to discover new biomarkers, proceed in clinical trials for testing and finally implement the results in clinical practice. These are obviously high-risk projects and they would not have been possible without constant and longstanding financial support.

THRMB focuses on stem cell research and regenerative medicine to replace lost cells. It integrates biomedical approaches with recent developments in nuclear physics, which enables establishing the turnover of cells in human tissues. One of the achievements was to establish a map of cell turnover in the human body in health and disease. It also provided knowledge necessary for the development of diagnostics and regenerative therapies in, for example, neurology, psychiatry, cardiology, obesity and diabetes.

The overall aim of the Centre for Studies on the Therapeutic and Prognostic Potential of Mesenchymal Cells of the Tumour Stroma (STARGET) was to improve

cancer diagnosis and treatment. This was to be achieved through coordinated efforts that test the hypothesis that mesenchymal cells of the tumour stroma exert instructive and tumour-stimulatory functions, which carry prognostic information and are tractable to pharmacological interference. The research aimed to develop novel diagnostic, prognostic and therapeutic tools based on the biology of tumour fibroblasts and pericytes. A key characteristic of the proposed strategy is the integration of parallel studies of pericytes and fibroblasts in both physiological and tumour settings. A second defining feature is that drug target identification is predominantly achieved through characterization of human tumour tissue, rather than of tumour models. Thirdly, the program pays special attention to the development of novel animal models for target validation.

The aim of the Centre of Excellence in Developmental Biology for Regenerative Medicine (DBRM) was to be an internationally leading centre in the fields of developmental biology, stem cell research and neurobiology, areas that are cornerstones for regenerative medicine. DBRM seeks to unravel the molecular basis for stem cell differentiation to specific cell fates and use this information to generate new paradigms in cellular transplantation and regenerative medicine. To strengthen the information flux between basic and clinical science, it has launched a Translational Research Centre to work closely with clinical scientists to develop new paradigms of use for the clinical setting. DBRM also aimed to stay at the forefront of technical development in a number of areas such as transcriptomics, proteomics, and epigenetics.

### **KI ability to host and develop CoEs**

Within KI, Linnaeus funds were crucial in jump-starting new research environments for all Centres. They helped to bring in additional funds (e.g. from Wallenberg). The funds were generally not used for funding the individual PIs, but mostly were kept in the Centre for common objectives. Strengthening translational medicine was one of the major goals and achievements, by bringing together clinical and preclinical researchers as well as researchers from different fields, like haematology, dermatology and cardiovascular groups in the case of CERIC.

Very significant use of the money was for networking and creating communities, by often weekly seminars as well as retreats. Additional uses were for opening up innovative methodologies like MRI and Artificial Intelligence for testing liquid biopsies and developing infrastructures like biobanks and MRI based screenings from large population-based studies, establishing networks beyond Karolinska and beyond Sweden, leading to new early diagnosis tests and strategies (CrisP). Stem cell research has greatly been advanced by testing live tissues and the development of sophisticated single-cell carbon dating technologies (THRM). In one of the centres (DBRM) Linnaeus was also closely tied to curriculum development and teaching, especially short courses and a summer school. Events like seminars and courses, as well as weekly seminars, retreats and courses, were seen as effective means of community building.

All Centre representatives stressed the enormous importance of both the duration and flexible use of Linnaeus Centre money as well as the crucial complementary role of the Linnaeus program for basic research between individual SRC project funds on the one side and thematically dedicated programs like the Strategic Research Areas

(SRA). It was also observed that many funding programs at one time tend to run or shift over time in the same direction, so it is important to have a program like Linnaeus with no strongly fixed objectives. Centre grants, however, were felt to effectively counter the fragmentation of the funding system and create interdisciplinary and interdepartmental collaboration that had not been pre-existing.

Two of the Centres (CrisP, CERIC) are continuing and the others would have liked to have at least continuing small money for maintaining the research community beyond the Centre duration.

Quite a few directors served for all of the ten years. In one Centre there was a change in Director at about half time. Their role was not seen as micromanagement, but more in mentoring and guidance (the metaphor of "marriage counselling" was used). The PIs usually met each other twice a semester. Based on the focus group interviews, leadership was seen as quite democratic. The guiding principle has been largely on individual projects rather than large-scale science teams. In several of the Centres, the administrative positions were also used for managing the other programs. Programs had no official contacts or meetings among each other. There has not been a structured strategic discussion channel of the projects with the university leadership.

We heard little to nothing on the role of Linnaeus Centre in the recruitment of senior scientists, but much about their very important role for recruitment at the junior level using open calls with significant shares of postdocs from abroad. International visibility via the Centres is seen as less important for the senior scientists, but important for recruitment and recognition of the younger researchers.

Lessons learned: The panel got the impression that for KI the initial objectives of the Swedish Research Council were not sufficiently clear, especially in regard to interaction between Centres and the University. There was perhaps too little exchange between Linnaeus Centre leaders within Karolinska. One PI noted that, at the time of the initial call, conditions for continuation should have been spelled out.

The University representative (Deputy Vice Chancellor) stressed the huge success of the Linnaeus centres. However, the university does not specifically engage in promoting the international visibility of LCs, but rather sees the international visibility transmitted through high profile publications and also very prestigious top-level international conferences, such as the stem cell research conference that comes to KI.

The university representative stated the Linnaeus Centres had no direct role in recent efforts of restructuring KI. Also, he maintained that KI has no overall 'research strategy'. That, however, was contradicted strongly by some of the Centre representatives who highlighted the strengths of KI in regard to cancer research and other focus areas.

The University pays great attention to infrastructures (e.g. animal facilities) and is part of national and European ESFRI infrastructure competitions. The infrastructures developed by the Linnaeus Centres seemed to be of lower significance in this overall context.

With respect to industry contacts, the Linnaeus Centre representatives pointed out that, while quite a few of the big Swedish Pharma industries have gone, the Swedish Government especially supports academic connection to Swedish firms. Linnaeus Centre reported Capacity building at the Royal Institute of Technology (KTH)

contacts with biotech start-ups and also to Phillips and Google in the area of AI, image recognition and digital pathology.

In the final discussion it was generally agreed how frustrating it was that “international stars” leave (due to non-competitive salary levels?).

Furthermore, there was a concern that an extension of Excellence Centre grants should not come at the cost of basic SRC granting mechanisms. A future program might consider encompassing a sustainability concept beyond the 10-year horizon.

## 1.5 Capacity building at Royal Institute of Technology (KTH)

### **Linnaeus centres at KTH**

In the Linnaeus program, three Centre proposals at KTH were successful, namely ADOPT (in the field of optics and photonics), FLOW (in the field of fluid dynamics), and ACCESS (in the fields of signals and systems). The Royal Institute of Technology had a role in the pre-selection of proposals, based exclusively on excellence, and has worked closely with the Centres to foster their ability to manage and communicate their work.

The ADOPT centre was successful in fostering excellent science in the domains of optics and photonics. Although initially it did not establish a strong identity, in later stages it stood out and was recognized in the community. This worked well towards attracting brilliant new students. The Centre has ended its function, and has split in two main directions, that have now been incorporated into other structures. However, the role of the Linnaeus Centre in making KTH a main actor in the field, including its participation in the EU FET Flagship Quantum Technologies program, must be acknowledged.

The FLOW centre had an important function in housing KTH research in the fluid dynamics domain, gathering researchers from mechanical and aeronautical engineering and applied mathematics. The Centre has now transformed and been institutionalized into a Division of the Institute, which organizes most of the research on the topic at KTH.

The ACCESS Centre followed an exemplary path in the implementation of the Linnaeus program strategy. A very strong image was established from the beginning, involving professional help, and funds were used for established visiting professors and open postdoc positions that were attractive in the international competitive environment. This led the Centre to grow substantially and reach levels of international excellence and critical mass, thus going on to attract substantial further funding from other sources. After the Linnaeus grant ended, the Centre has evolved and transformed into an even broader and larger initiative under the SRA funding directed towards the Digitalization objective of the Swedish government.<sup>2</sup>

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<sup>2</sup> <https://www.regeringen.se/regeringens-politik/digitaliseringsstrategin/>

### **KTH ability to host and develop CoEs**

Linnaeus centres established at KTH have been very successful in several respects but in different ways. The assessment of how much of this success was due to the Linnaeus program alone and would not have been possible if the Centres were not established is not an easy judgement to make given the outstanding quality of scientists involved in the Centres. However, there is clear evidence of how much the Linnaeus program approach and philosophy has impacted KTH. This HEI has capitalized on the Linnaeus program experience by establishing a large number (50) of centres of different nature, but with commonalities with the original few. These are regarded now by the KTH as a strategic organization instrument, as they go across existing structures (Faculties and Departments) and work as catalysts for interdisciplinary, interdepartmental research aggregations contributing to the institutional research profile. KTH organizes training courses and workshops for Centre leaders to share experience in management, communication, IPR protection, industrial involvement.

For all its Centres, the University put in place a structure and management culture that is inclusive and focused on community building. The gender balance was unsatisfactory, but measures were taken including a women's network, mobility and targeted research grants, which brought about definite improvements.

The three Linnaeus Centres have a strong identity, and they project a well-defined image in their respective fields of engineering. The organisation of the Centres is well thought out and very functional, with effective management and strong facilitation by the HEI.

The establishment of Graduate Schools in FLOW and ACCESS was very important to help make KTH more attractive, reaching larger numbers of students, who, once graduated, have then spread around the world, thus participating in the dissemination of a positive image of the Swedish research environment.

The direct contribution of KTH to the funding of the Linnaeus centres was reported to be limited to 14 percent, falling short of the original 50 percent objective. This number somehow reflects ambiguities on how co-funding is accounted (e.g., it does not include the person months dedicated by PIs on a KTH salary), but a more structured and generous approach would have favoured the Centres even more. On the other hand, the Institute has considerably developed research infrastructure and facilities available to the Centres.

Of particular note is the quality and amount of external collaborations with public and private institutions and external funding raised by the Centres (this was well documented by the ACCESS Centre, while other Centres highlighted it in oral interviews). External advisors both from academia and industry helped to anchor with a wider group of stakeholders, providing a model for collaboration between researchers and with external stakeholders, extending to education practices, now being applied to the University at large. Collaboration with industrial partners is intense in focus areas of research which are very relevant for mitigation of societal challenges.

## 1.6 Capacity building at Linköping University (LiU)

### Linnaeus Centres at LiU

The host University now covers a broad range of academic fields but has a strong focus on engineering approaches to complex problems. The three Linnaeus Centres reflect this provenance and were formed following the calls of 2006 and 2008. The first of these, Lili-NFM, has a focus on the atomistic nature of materials, and seeks to make materials perform their functions better through new methods of synthesis and processing. The other two, CADICS and HEAD, had themes, respectively, on artificial intelligence, sensory informatics, automatic control, vehicular systems and scientific visualization; and on the dynamic interplay of human cognition and auditory signal processing in the design and creation of better hearing aids. Each of the centres mentioned the "added value" arising from the stability of having 10 years of funding, and the diversity of expertise brought together under the Linnaeus Centre umbrella.

The first director of NFM made the point that he approached the Rector of the University early to urge him to recognize "materials science" as a key strategic area for the University to which he secured a sympathetic response. This happened just before the Linnaeus call. The aim was to bring a multidisciplinary group of four professors together under a larger umbrella, and that was how the Linnaeus centre was formed with the then successful application by 10 professors. The University sustained its support in various ways, and the Centre was later to absorb a Strategic Research Area initiative and then morph into an explicitly industrially oriented Centre as exists today. CADICS likewise saw the Linnaeus program as a crucial catalyst for bringing diverse expertise together, which greatly helped later successful applications for a Wallenberg Centre in conjunction with five other Swedish Universities. HEAD had the intellectually interesting ambition of wanting to bring "cognition" into the design of hearing devices that had previously focused purely on sensory aspects of audition. The danger of augmenting "signal", desirable as that may be, is that a device could also augment "noise" - where noise is traditionally thought of as background sound but, in this new way of thinking, could include signals that are not relevant cognitively. It turns out to have been of sufficient importance to build a new company marketing novel hearing aid devices.

Facets of recruitment have varied across the centres. NFM was given the possibility of recruiting at the tenure-track level and identified a Swedish researcher at the Massachusetts Institute of Technology (MIT) who was successfully recruited as an Assistant Professor. CADICS noted that it is sometimes difficult to recruit internationally as potential recruits at the appropriate level of expertise often prefer to go to Stockholm. However, it did successfully recruit nationally. HEAD indicated that the existence of the Linnaeus Centre meant a lot in terms of recruitment, including the international recruitment of an expert in the neural basis of speech understanding, who made a major contribution but decided after some years and for personal reasons, to return to Canada. All of the centres had international PhD students.

With respect to structure and leadership, the three Centres took different approaches. NFM set up what they called a "resilient" structure that coped very well when the Director moved to a senior position in Stockholm. HEAD had confidence

in its leadership such that a single Director remained in charge throughout the 10-year period. CADICS deliberately set up a two-layered structure of a senior executive managing group at Professorial level, and a separate junior faculty group that provided balance and helped to feed in new ideas.

### **LiU ability to host and develop CoEs**

One of the Centre Directors coined the phrase that the strategy across the board was "Application-inspired basic research". This resonated with the evaluation panel. What this means is that, as scientists, they are loyal to the absolute need for bottom-up fundamental research but are guided by an eye for potential applications. This facet of strategy is not always seen elsewhere as some other Centres see impact exclusively in academic terms, such as citations. The leadership of the University played an active part in securing the Linnaeus funding, with no fewer than 15 potential Centres appraised internally prior to the choice of 8 applications of which 3 were successful. They then supported these three strongly with, for example, materials science (NFM) now well advertised by the University. The University management respected the need for freedom by their academic staff to pursue research as they saw it, a principle they applied as much to the Centres as to others across the University. Even though the Linnaeus funding has ended, there is a lasting legacy of the initiative.

Numerous achievements were mentioned. NFM identified many strands of knowledge transfer ranging from the interactions between senior and junior scientists in seminars, spin-out companies, patents and the sheer number of trained PhD students who have gone into industry; this must be good for the Swedish economy. CADICs mentioned a variety of developments, notably the creation of a "virtual visualisation table" that the Centre developed which is now being used in the training of medical students and, especially, surgeons. HEAD noted that "cognitive hearing science" is now definitely on the map in the academic field, that they organise an international conference every three years, and that the Centre's research is being very well cited. Beyond this, they have helped support a hearing aid company, Oticon R&D (Eriksholm), that uses brain training algorithms which help listeners sufficiently that many clinicians are now showing an interest in these devices.

## **1.7 Capacity building at Lund University (LU)**

### **Linnaeus centres at LU**

LU is a large and comprehensive university and it is internationally well known. LU was extremely successful in both the 2006 and 2008 calls, securing 14 Centres altogether. These were divided across all four main fields. The centres in medical sciences: LUDC (genetic and metabolic complexity of diabetes), Bagadilico (novel therapies for basal ganglia disorders), Hemato-Linné (normal and leukaemic haematopoietic stem cells and blood lineage) and NRC (neuroscience, nano- and microtechnology and biotechnology); in natural sciences: LUCCI (carbon cycle and climate interactions), LLC (multidisciplinary laser spectroscopy), OMM (organizing molecular matter), CanMove (evolution and ecology of animal mobility); in human

sciences CED (economic demography), LUCIE (innovation, entrepreneurship and knowledge creation), CCL (cognition, communication and learning) and LUCID (integration of social sciences and natural dimensions of sustainability); and in engineering sciences: NanoQE (nanoscience and quantum engineering) and LCCC (controlling complex engineering systems). In terms of the total number of publications coming from the Linnaeus Centres, LU is in its own league compared with the other universities. Specifically, the Linnaeus centres constituted over 20 percent of all publications from the university. Moreover, in all four research areas the LU centres had a high share of top 10 percent publications, indicating the broadest disciplinary spread of excellence among the ten HEIs.

**LUDC** (genetic and metabolic complexity of diabetes) is challenging the historical classification of diabetes into autoimmune type 1 and insulin resistant type 2 diabetes. LUDC seeks to explain all diabetes as combinations of inflammatory and metabolic developments. The resulting spectrum of diabetes is very heterogeneous. This complexity is far from fully elucidated. The program has led to the creation of landmark publications renewing the diabetes spectrum of disease classification. This result is an internationally acclaimed prerequisite for the development of novel diagnosis and treatment strategies in what has thus become personalized diabetes therapy.

**Bagadilico** (novel therapies for basal ganglia disorders) has succeeded in developing a novel understanding on the diagnosis of diseases of the basal ganglia, most notably Parkinson's and Huntington's diseases. Modern imaging, cell and molecular biology have been used to identify molecular events underlying neuronal dysfunction and cellular decline. In addition, relevant objective and self-reported outcome measures are being used to gauge the subjective effects of diseases and treatment for the lives of the patients and families, and their overall societal impact. The project seeks to become a platform for novel forms of therapy and also evaluates developments in regard to their ethical and societal impact.

**Hemato-Linné** (normal and leukaemic haematopoietic stem cells and blood lineage) is based on the long-standing role of LU as one of the world-leading research environments for normal and leukaemic hematopoietic stem and progenitor cells (HSCs). Although haematopoietic research remains one of the most progressive research fields of somatic stem cells and lineage development, Sweden has until recently lacked a significant haematopoiesis effort. The existing prominent faculty has been enlarged by recruitment of additional investigators in basic and applied sciences. Projects of treating rare haematological disorders by gene therapy have matured to the stage of clinical testing. The Linnaeus CoE has also become an excellent training and career opportunity for young scientists.

**NRC** (neuroscience, nano- and microtechnology and biotechnology) – The Neuronanoscience Research Centre (NRC) has formed an interdisciplinary centre across four Faculties. It has studied fundamental mechanisms of memory formation and retention, information processing and physiology-based treatments in patients. A high-risk avenue has been pursued in the development of brain-machine interfaces (BMI) with ultra-thin multi-channel electrodes for high resolution neuronal readout and stimulation. Such BMIs might eventually allow us to enter the brave new world of managing pain, motor or learning deficits, or control prosthesis and robotics by pure thought. The NRC has had a significant educational impact.

**LUCCI** (carbon cycle and climate interactions) – Climate change and the sustainability issues surrounding it need no introduction. One can only commend LU for their foresight in bringing this CoE together at a time when the geosphere-biosphere-atmosphere-ocean interactions of the carbon cycle were not yet on the top of everybody's agenda. LUCID has sought to cultivate a very systematic access to studying sustainability problems with special focus on the carbon cycle, both in research and as a Faculty overseeing Masters' education. It is well tied into international research networks, and actively participates in their multinational projects.

**LLC** (multidisciplinary laser spectroscopy) – This impressive Linnaeus Centre has been built around the notion of how to make the photon in general and lasers in particular work for mankind, especially in the areas of astrophysics, laser spectroscopy, spectral imaging, structural dynamics and sophisticated diagnostics. Within the excellent existing infrastructure, the Linnaeus CoE funding has afforded significant additional interdisciplinarity and success, both with regard to scientific output and societal impact.

**OMM** (organizing molecular matter) – The OMM CoE has rather successfully created interdisciplinary interaction both in basic and applied scientific research on the intermolecular interactions in liquids and colloids. Quantum chemical calculations, statistical mechanical methods and computer simulations have been employed to understand molecular interaction and colloidal biology. The concepts developed continue to inform multiple projects.

**CanMove** (evolution and ecology of animal mobility) – This fascinating CoE applies an across-the-board interdisciplinary effort to combine and understand animal migration with the help of newly available tools in areas such as microelectronics and genetics. The body of know-how and data developed is very impressive and a treasure trove for generations of projects to come. This Linnaeus Centre is certainly one of the success stories of the program.

**CED** (economic demography) – Not only is Sweden a highly developed country and a model of a welfare state, but also has very well-organized population records dating back to 1750. This CoE has put a major effort into creating a combined digitized data source for such records. This has enabled it to engage in comparative research studying the transition from an agrarian into a modern industrialized welfare state, and how these changes influence individual and inter-generational behaviours in different societies. A Research School in Economic Demography will provide Swedish and international students with training and data for the next generation of scientists in this field.

**LUCIE** (innovation, entrepreneurship and knowledge creation) – In a remarkable interdisciplinary process, the LUCIE CoE has sought to develop a deeper understanding on the multitude of interactions defining the innovation process, and more specifically in the context of entrepreneurship and knowledge creation. Four different Faculties have been involved in this process that has developed significant teaching, and scientific as well as societal impact, and has contributed to redefining how the university research environment in modern day industrial societies is becoming more and more of a value creation hub and economic crystallization centre.

**CCL** (cognition, communication and learning) – The CCL CoE has created an interesting interdisciplinary focal point at the intersection between the neuroanatomy, imaging and neurophysiology of cognition and communication, more specifically the processes underlying the process formally known as “learning”. This work has created significant inroads into our understanding of especially the temporal aspects of language acquisition, reproduction and conceptual plasticity over time, and how our ability of planning and effecting communication is influenced by our environment.

**LUCID** (integration of social sciences and natural dimensions of sustainability) – The LUCID CoE marks a laudable effort to tie the social sciences together with the natural sciences into the problem solving of mankind’s sustainability challenges. This multidimensional matrix project has sought to develop ties both regionally, nationally as well as in international networks.

**NanoQE** (nanoscience and quantum engineering) - The Linnaeus Centre Nanoscience and Quantum Engineering lies at the core of prioritized research at Lund University, by the Engineering Faculty (LTH), as well as by the Faculty of Science. The Centre addresses the next frontier research questions of achieving controllable quantum systems, nanoelectronic devices, quantum-electromechanical systems and single-molecule level technologies by systematic progress in quantum transport and nanophotonics and is a European academic powerhouse in this field.

**LCCC** (controlling complex engineering systems) – This CoE has addressed the complexity challenge inherent to modern day industrialized societies by developing modern approaches to governing and synthesizing feedback controls in complex systems, with a particular focus on robustness and scalability. Both the scientific as well as the societal and industrial output of this Centre have generated significant national and international impact.

Some of the Centres were initiated as new constellations through the Linnaeus program while some had a previous track record of multi-team operation. The Linnaeus grant provided LU with a clear new impetus to build the operations and specially to expand multidisciplinary and provide important continuity when needed. The leadership was actively engaged in facilitating the building phase. The Centres operated first outside of the Faculties but were then integrated into them, not as static entities but as dynamic ones evolving with time, needs and turnover of academic staff, and connected to education. Joint aims were developed at the application phase.

It was considered, that unlike any other strategic programs, the Linnaeus program offered long-term planning possibilities and freedom to tackle high risk/high gain research topics. The long-term nature of the program was considered very important. In several instances the Centres were used as a basis for the SRA initiative. Moreover, in several Centres access to infrastructure was important but there are worries for the future funding of infrastructures.

With one exception, LU had no HEI-level exit program. However, the Centres were informed two years in advance of the program’s end that there would not be further support, and thus were prepared for the transition. In fact, most of the Centres continue their operation and are successful, and in most cases the Linnaeus constellation provided the basis for further funding proposals. Some are now virtual and are of mixed visibility. Importantly, following the end of the Linnaeus program,

overall the centres had a robustly increased number of personnel and total funding. They also had made great strides in developing the gender balance at the highest academic level of professorships.

In several cases existing structures preceded the Linnaeus centres, such as the Lund laser centre that had existed since 1996. The Linnaeus program came up at the perfect time, because the LLC Lund laser centre had funding challenges, although researchers were collaborating. The Linnaeus grant was only 6 percent of their budget, but this had a huge effect, as now the Centre's board could put the extra money where it was critical and strategic, such as retention/bridging of excellent early career researchers. The effect was described as putting oil in a big machine!

### **LU ability to host and develop CoEs**

The management has a clear appreciation of the role and value of the Centres of Excellence. In the beginning it was not clear how to place the centres within the University structure, and it was indicated that LU provided opportunities to see what works and what does not. Subsequently, in the early phases of the Linnaeus program, it was realized that the Centres should be linked with Departments, thus providing practical solutions for recruitment of faculty. The Faculty-linked structure worked well for some Centres, but there were also challenges in keeping several departments coordinated. In both calls the HEI was able to guide the merging of some applications into broader interdisciplinary programs – this was appreciated by several of the Centres. However, systematic coordinating mechanisms at the HEI level were not in place. All 14 Centres received co-funding that could be used in a flexible manner on yearly basis. If there is a new program, the HEI would advocate interdisciplinarity for its proposals. Altogether, the leadership pointed to the huge value of the Centres in the national competition and their important prestige. It was considered that even those that did not succeed in the grant application benefitted from writing the applications, and some of those became successful and are continuing.

On account of the large number of Centres, one would expect a large variation in organisational issues. After the initial phases, an overriding principle was to build a matrix across Departmental levels, and this was considered transformational, and at the same time rooting the Centres to the departments. The program led to the integration of different research programs and disciplines in a new way, including building critical mass, e.g. in the medical areas they never gave any money for project grants, and instead focused on positions and rejuvenation. The program also led to expansion of leadership capabilities, including rotating leadership positions and involving younger scientists as well. Subsequently, the Linnaeus program has catalysed a program for university level leadership training.

The possibility of using the funding to recruit has been an asset of the program and it has also allowed gender issues to be tackled. The positions were publicly advertised and the majority came from abroad, leading to a clear increase in international postdocs. It was realized that more senior-level recruitments need tight participation of Faculties to secure long-term retention of recruited personnel. There was freedom to use cash for bridging funding and for retaining talent.

The Graduate Schools were much appreciated, allowing exchange of know-how readily between groups in an informal manner. However, the Schools were not part

of all Centres and at University level overall only 25 percent of students belong to Graduate Schools, which served to attract students from all over the world, leading to increased internationalization in the longer term. Altogether, there were a multitude of meetings, events and platforms that supported knowledge transfer.

It was indicated that those research lines started 13 years ago are not necessarily the same at present as the research questions have evolved, such as for the LLC laser Linnaeus Centre, exemplifying renewal of the profile. The Centres would appreciate an exit strategy and better plans on how the initiative is taken care of after the end of the program, so sustainability should be addressed in the future. However, the Linnaeus program had a big impact in that it helped to build knowledge that was used in getting large grants, e.g. from the Wallenberg foundation, with a lot of overlap and possibilities to extend employment of staff.

Examples of success brought out in the interviews include LUCCI, which now serves as a portal for the distributed ICOS infrastructure measuring greenhouse gases all over Europe. The set of instruments for CCL is now used widely across the University; it is a University project rather than at Faculty level and may be a national infrastructure. Most of the Arctic sites now offer visits to postdoctoral scientists and students. However, some small Arctic stations had to be dismantled due to lack of funding.

The Linnaeus grant and the co-fund were considered rather small. Nevertheless, both the grant and the co-fund were much appreciated as oil and glue for the Centres, facilitating cross-departmental work, helping to recruit and retain people, and providing flexibility. The funding was managed bottom-up and at the Faculty level and not at University level, apart from the University concerns such as gender equality. The long-term nature was universally appreciated as well as the freedom to take risks. The Linnaeus grants worked as a leverage for future success and were said to have “created miracles”. The University has an overarching infrastructure strategy, and those infrastructures related to the Centres are still being used, but funding infrastructures in Sweden is considered always a challenge. There was discussion on whether the University should design how the Centres should operate. In response it was indicated that the University should keep diversity as different areas need different support.

With respect to lessons learned, a stronger approach to diversity would be built. They would address the concern that money goes to established older staff, and not sufficiently to women and younger staff. It took the Centre a couple of years to apply any rules internally to support diversity.

The HEI leadership saw the Linnaeus program as a process for profiling, and it resulted in new long-term grants, recruitment of new people and rejuvenation of some areas. Almost all Centres are still going strong. The culture of the University has changed along the lines of the Linnaeus program towards more interdisciplinarity and crossing Faculty borders. Overall, LU has now 30 interdisciplinary centres, largely formed bottom-up and many apparently related to the previous Linnaeus program, though there have also been changes in the environment.

With respect to the future, they identified a need to co-operate more between different Universities as part of the future strategy. On the other hand, since LU has all disciplines, interdisciplinarity does not in all cases require inter-university work.

For future funding it is essential that it is long-term with freedom to be high-risk and bottom-up.

It appeared that the Linnaeus program as such was not used strategically at the university level to increase the international visibility of the university. The leadership rather emphasized that the Centres themselves create and then display visibility. Indeed, it was assessed that the international visibility of several of the Centres had increased, and the view was that profiling took place in practice, e.g. regarding the LUDC diabetes research.

Societal relevance was not included in the original goals of the environments, but according to the management, all Centres have contributed to this as an obvious part of their activity, though varying from a basic research profile to more diverse environments, e.g. including patients. In the discussion it was indicated that with hindsight, a bigger share of the funding could have been going to innovation. This arena has changed a lot, and while 10 years sounds a long time, it takes time to build connections. Some centres had grants from Vinnova, which are close to the industry, however their short 3-year duration hampers their use for student positions. Regarding NanoQS, this was seen as an example of fundamental research with societal relevance. They recruited a liaison scientist with expertise of IPR, and the centre spun off 5-6 companies. However, in general, interactions with industry could have been more extensive.

## 1.8 Capacity building at Swedish University of Agricultural Sciences (SLU)

### **Linnaeus centres at SLU**

The host university has a particular status in the Swedish system of higher education: their responsible ministry is that of Enterprise and Innovation, which includes the Ministry of Rural Affairs. Not only should SLU, as a university, strive for excellence by investing in basic and curiosity driven research, but it also has a commitment to the agricultural and environmental dimensions of society in which it has specialized skills.

This Linnaeus centre originated in the vision of a couple of PIs, brought together by an imaginative coordinator who was later recruited by Max Planck. The transition to a new leadership was carefully prepared, and went smoothly, largely because the original coordinator remained linked to the University and Centre for 20 percent of his time. Management was then organized using a rotating leadership, with regular board meetings of all senior PIs and well-defined potential conflicts of interest (e.g. between department chair and centre leader). With teambuilding in mind, the PIs collectively undertook an external leadership course. The objectives of the Centre were clearly set out ab initio, including improving the number and impact of high-quality publications, which turned out to be a success.

A key added value of the Linnaeus Centre is that PhDs and postdocs were recruited from all over the world, e.g. via 'Nature Jobs', and several of the foreign recruits have been retained. The Centre structure comprised three sub-groups, with a very flat organization in which PIs, postdocs and PhD students worked closely

together. Every PhD student had a thesis committee of three co-supervisors. In this way, several generations of PhDs and postdocs have been recruited and trained. Some remain active in academia, others in industry, and last but not least, in diverse government administrations. This is an important legacy.

The impact of the Linnaeus funding was tremendous: there was substantial growth in activities, people and their professionalization between 2005–2015 that remains consolidated as of today. An inspiring example is the ‘Lighthouse Project’, launched in 2007, as a ‘hot house’ for bringing together all ICE3 scientists and postdocs, for shedding light on and formulating new cross- and transdisciplinary ideas. The Centre provided cohesion and interplay between several projects and perspectives. Important breakthroughs include mosquito chemical ethology (with a potentially deep impact on malaria prevention and curation) and in understanding the changing behaviour of insects under the influence of climate change. These were leveraged into increased funding for projects in and with developing countries. There was a constructively critical atmosphere. Even though there was no external scientific advisory board installed, and despite the absence of instructions from SRC, a self-initiated external review was performed after 4–5 years, upon which many recommendations were implemented.

It is reported that a most direct and impressive legacy of the Linnaeus funding is the creation of the first Max Planck centre in Scandinavia, co-funded with 500K Euro from the Max Planck Institute in Jena, and 500K Euro for university funds, with potential opportunities for training and exchanging PhD students and postdocs, research mobility, sharing infrastructure and joining forces for new funding. This was inaugurated on January 27th 2020.

### **SLU ability to host and develop CoEs**

Impressively, the leadership of the University recognized that Linnaeus funding was of utmost importance in the further professionalization of the University. In order to facilitate the impact, the University doubled the Linnaeus money through co-funding. In its own right and as a role model, the Centre definitely helped in developing a cooperative culture and a solid platform for fundamental research that, before Linnaeus, was less prominent in the University. This enabled longer term/higher risk research projects. The interaction with the University governance was on the Faculty level, which turned out also to be very supportive. Even though ICE3 remains unique as a Centre in this small University, there is already an inter-university platform with the Umea Plant Science Centre. Preparations and a first application are ongoing for an animal welfare centre, and a concerted effort around societal provision of food.

It was noted in discussion with SLU that the Swedish Linnaeus Centres across the country never met collectively. Their disciplines were perhaps too diverse for this to have been perceived as valuable, but there were organisational aspects and lessons that could have been shared. Their absence was considered to be a missed opportunity as such dialogue could collectively strengthen the branding and international visibility of the Swedish research system.

## 1.9 Capacity building at Stockholm University (SU)

### Linnaeus centres at SU

In the Linnaeus program, three Centre proposals at SU were successful: BBCC (Bert Bolin Centre for Climate Research), OKC (the Oskar Klein Centre for Cosmoparticle Physics), and SPaDE (on social policy and demographics). The Rector of the University played an important role in obtaining the funding but there was no overall strategy in selecting proposals for the Linnaeus program. Management links with the Centres have largely been confined to their respective Faculties. All Centres have strong legacies.

SPaDe's origins were in a Masters program including geographical and spatial components of demography. The Linnaeus funding provided the vehicle for cohesion and synergy between diverse academics, bringing critical mass of Faculty and postdocs together. The Centre has a lasting legacy of data infrastructures including a longitudinal study starting in the 1960s with continuing Register-based infrastructure funding. Outreach was strong, and the work continues under SPaDe branding.

The field of climate research was poorly integrated at the time of founding the BBCC Centre, which brought together specialists in fields including palaeoecology and modeling to develop and use a new toolbox. This fostered collaborations and also focussed on Arctic research, which has become increasingly significant as climate change has taken centre stage in world politics. The Centre grew to 350 researchers, the largest climate centre in Sweden, with both scientific and societal relevance and a particular responsibility to bring science to the public.

OKC started as three groups - two in physics and an Astronomy Department - with pockets of excellence spread out between different centres. Linnaeus funding was the catalyst that brought them together. Physical proximity of researchers had major benefits, and the result was a highly international Centre, which now functions as a focus for fundamentally important research, e.g. in dark energy and gravitational waves, with high levels of additional funding and a Nobel prize winner.

The three Centres had contrasting origins, ranging from dispersed pockets of excellence (OKC) to an unassembled set of academics with common interests (SPaDe). The flexibility of the Linnaeus funding was key to allowing the researchers to pick their own future hot topics. Their research focus changed over time and each Centre's management structure also evolved. The three Centres were managed in different ways, reflecting the norms of the Faculties. An innovative leadership pattern was established in BBCC: all leadership positions were shared to provide resilience. There was also variation in the relationship between the Centre leadership and the University leaders.

Recruitment of postdocs was strongly international, which was a novelty for two of the areas. At the time of founding the centres, tenure track positions did not exist, so the funding was mostly used for paying PhDs, postdocs and visiting faculty. Some funding was used for culture change, increasing outreach and external communications, as well as seminar series and platforms for "cross-talk" between specialisms – these permanently changed how the Faculties work. All three Centres are continuing to function in new forms, but the Centre identities are still recognizable.

### **SU's ability to host and develop CoEs**

Linnaeus centres established at SU have individually been very successful. The contribution of the centres to the University's development is clear - although OKC in particular was built on pre-existing strengths, the Linnaeus funding was a catalyst to increase the level of cohesion in groups and was also important in developing a model of university-level infrastructure funding. In the case of OKC this has now snowballed into the joint funding of a new building as the group has been so successful.

SU supported the Centres by investment, but didn't actively link the different Centres, which remained embedded in their respective Faculties. Increasing visibility of SU was largely left to the centres themselves. There is apparently no university research strategy, although the current profiling of the university with eight broad profile areas includes the Centres. The University now participates extensively in international and European programs and facilities. They are now one of eight Universities that form the European civic university Civis, which is an extension of Erasmus but includes research and they have a hub based on climate. A Swedish icebreaker in the Arctic is a research platform to which they offer international access.

## **1.10 Capacity building at Umeå University (UmU)**

### **Linnaeus centres at UmU**

The host University thinks of itself as a "compact" University rather than a small one, in the sense that many staff know each other across Departmental boundaries and through living close by in a medium-sized city. Accordingly, the creation of the Linnaeus program in 2005 was one in which the University staff, seeking potential multidisciplinary, inter-Departmental Centres, felt at ease. The University conducted an internal triage appraisal of potential applicants of which ALC and UCMR were ultimately successful. Now, 14 years later, UCMR is leading the Swedish node of a large and comprehensive Nordic European Molecular Biology Organisation (EMBO)<sup>3</sup> Centre on molecular biology, including microbial diseases, with bases in Denmark, Finland, Norway and Sweden. We suggest that UCMR be considered one of the "jewels in the crown" of the Linnaeus Centres. ALC has become the important Swedish hub in the 27-country Survey of Health, Ageing and Retirement in Europe (SHARE).

The ALC Linnaeus Centre was built as a research centre on ageing on the foundations of an existing population database with relatively recent health records, but also Parish records extending back to the 16th century. It was hosted in the Faculty of Social Sciences, but bridged three separate Faculties, and has a continuing profile within the University beyond the duration of the Linnaeus funding. The primary aim was to conduct research based on (partially linked) register and survey data focusing on a variety of population and demographic issues

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<sup>3</sup> <https://www.embl.de/research/partnerships/remote/nordic/index.html>

associated with ageing; called the Linnaeus DataBase, it is one of the rare examples of the use of the Linnaeus name for branding. The bulk of the work concentrated on the effects of extending working lives and physical activity on cognitive decline. The UCMR group was also an explicitly "bottom-up" initiative in which a group of 10–12 scientists sought to work together to strengthen the important area of infection biology. Forming the Centre offered the opportunity to expand existing strengths with molecular microbiology and chemical microbiology, with corresponding infrastructure and human capital investments.

ALC were successful in recruiting early career social scientists, including postdocs. They also attracted guest researchers who sought to use the valuable and developing database. They joined a Centre structure in which members of several Departments came together to secure intellectual synergy in their research, a synergy for which they were very glad to have the Linnaeus branding. The structure also included the creation of an Executive Board, chaired initially by the Rector of the University and later by a Vice-Rector. There was also a separate international external advisory board. UCMR also had an Executive Board, with the same transition from Rectorial chairing to that of a Vice-Rector but, in addition, there were representatives from both the Faculties of Medicine and of Natural Sciences, and external members of the Board from within Sweden. As the various lines of research coalesced into specific projects, the active role of the UCMR Board declined. There has lately been a further transition to the University oversight of this group with the transition of being the Swedish hub of the Nordic EMBO Centre.

UCMR identified major impacts with respect to well-cited and influential research, including a translational project on conjunctivitis now handled by a pharmaceutical company that has reached phases I and II of product development. There is also clear international visibility of this research group in attacking the major world problem of anti-microbial resistance. A very specific achievement was the successful attraction of international scientists to work in Umeå, of whom one was to publish the key original papers related to CRISPR:cas9 gene editing. The first of these papers in *Nature* (2011) has attracted >1900 citations; a second paper published in *Nature* a year later was the first to explicitly draw attention to the prospects of this form of gene-editing and has attracted >8000 citations. This investigator stayed many years, enjoying the Centre enormously, but was head-hunted by the Max-Planck Society and left in 2016. Aspects of knowledge transfer included the constructive discussion of ideas between senior faculty, junior faculty, postdocs and PhD students leading to ideas being taken up around the world and of interest to industry.

ALC has also been very active, with a doctoral program of 31 graduating students over the ten years of the Centre, and currently around 30 researchers publishing in the region of 40 papers per year. The work identified includes practical societally relevant information on the impact of exercise and other indices of health on life-course and living conditions in old age, especially based on a large community intervention study (Betula Västerbotten Study).

### **UmU ability to host and develop CoEs**

The leadership of the university recognised that Linnaeus funding was very important for the university, creating a triage process at the outset for selecting the

best potential applicants and the promise of co-funding to the applicants - which was honoured. They strongly endorsed the strategic policy of the distinguished first Director of UCMR, Professor Bernt Eric Uhlin, who stated that his aim was: "...to build on what was already strong and then hire the best people".

Both Centres continue to function and both are firm in believing that a "bottom-up" model is the right way to create and maintain such centres. ALC has, since 2015, been transformed into the permanent Centre for Demographic and Aging Research (CEDAR). The ALC team wondered if they took on too diverse a range of projects and would encourage a smaller number of focused research projects in future. UCMR would welcome the opportunity for clinical research fellows to be involved earlier in research as a "translational" bench of any future centre. They are incorporating this already in the new Nordic EMBL partnership in molecular medicine whose aims are to provide access to scientific infrastructure, including databases, facilities and instrumentation, as well as access to clinical materials, networks and training activities.

## 1.11 Capacity building at Uppsala University (UU)

### **Linnaeus Centres at UU**

Uppsala University has been home to four Linnaeus Centres, ranging from biology, computer science and engineering through to humanities: URRC (The Uppsala RNA Research Centre) funded under the 2006 call, and IMPACT (Impact of Religion: Challenges for Society, Law and Democracy), UCEG (The Uppsala Centre for Evolution and Genomics) and UPMARC (Uppsala Programming for Multicore Architectures Research Centre) all funded in 2008.

The four Linnaeus Centres established at UU have all achieved a well-defined identity and projected a positive image within their respective fields.

In 2006 the URRC brought together colleagues working on RNA within the disciplines of biology and chemistry to form three new interdisciplinary groups in the areas of i) RNA and infectious diseases, ii) RNA and systems biology and iii) RNA chemical biology - fostering integration between several small specialized research groups and creating critical mass. From the outset, the URR Centre recognized the importance of innovative cross-disciplinary postgraduate training to ensure sustainability, creating the URRC Graduate Research School, offering supervised projects, seminars and courses related to the Centre's cutting-edge research. This both raised the profile of the group and contributed to the vitality of URRC.

The low success rate in securing Linnaeus funding for UU under the 2006 call triggered a period of reflection within the institution and led to the University taking a more strategic approach to the 2008 Linnaeus call. Although ideas for the Centre bids remained 'bottom up' and researcher-led, for the second call there was much greater input from the UU senior research leadership team. For example, separate internal bids were initially received from the Sociology and Law Departments; the teams were then encouraged by the Faculty Dean to put these together, resulting in the successful multidisciplinary IMPACT Centre investigating religion and society.

Applications were also proactively encouraged from existing areas of research excellence within UU with, for example, UCEG drawing strength from the already existing Evolutionary Biology Centre (EBC). Recognising the challenge presented by multicore computing, UPMARC brought together colleagues with complementary skills from across engineering and computer science to focus on the development of techniques and tools necessary to support software development for these new platforms.

Once secured, all the UU Linnaeus Centres have been embedded into the general structure of the University and connected to education through various Masters programs, with joint aims being formulated from the beginning. In 2007 UU established a set of policies for the organization and management of research units and Centres from which the Linnaeus Centres have benefitted. The UU put in place a research leadership training program, recognizing that the skills required to manage successful collaborations are different from those required for excellent research. This has ensured strong leadership with good administrative capability and an open culture. All Centres successfully utilized the Linnaeus funding to attract internationally excellent PhD students and postdocs, fostering a culture of collaboration and knowledge exchange through seminars, workshops and international colloquia.

Actions to secure sustainability started immediately after the mid-term evaluations, with different approaches being taken depending on the specifics of the different Centres. Understanding the complex relationships between religion and society has become ever more relevant over the past decade, and the continuing collaboration of the teams from the fields of law, sociology and theology, initially brought together in IMPACT, has been supported by Faculty funding; a sister Centre focusing on religion and racism has been established and the group have recently secured a H2020 grant, ensuring longer term sustainability.

UCEG facilitated innovation and numerous new collaborations within the field of evolutionary biology, attracting a significant number of ERC grants and contributing to the continuation of the successful EBC - with the group now ranked in the top 10 in the world within molecular biology. In contrast, although highly successful during their periods of operation, both URCC and UPMARC ceased with the ending of the Linnaeus funding. Within UPMARC, the team explicitly recognized that over the decade of funding, research on multi-core computing had moved from being cutting-edge to mainstream and that innovative areas of enquiry required new and different constellations of collaborators. The UPMARC 'brand' however continues to attract international doctoral students to study at UU.

### **UU ability to host and develop CoEs**

The Linnaeus Centres have had very high visibility within UU. The scheme is seen by the senior UU leadership as having provided an important external catalyst to trigger strategic changes in the internal processes used by the University to ensure research excellence and renewal.

As a result of its low success rate in the 2006 call, in 2007 UU introduced a University-wide research quality assessment – the first Swedish HEI to do so. This research assessment exercise has been repeated in 2011 and again more recently. This transformation of the processes and culture of research across the whole of UU

is seen by the University leadership as a clear exemplar of the 'value added' by the Linnaeus program.

Following on from the focus of the Linnaeus scheme on cross-disciplinary initiatives, UU revised its internal support mechanisms to foster multi-disciplinary research, with an explicit drive to focus on key areas of strength and strategic importance. Evidence of the positive impact of this is reflected in UU's subsequent success in securing seven Centres funded under the Strategic Research Area (SRA) initiative.

The Linnaeus mission, fostering centres of excellence and bringing together a critical mass of researchers crossing disciplinary boundaries to explore common research goals has had a direct and significant impact upon the wider system of research governance within UU - with the value added by the scheme going well beyond the four funded Centres, driving positive change throughout the institution.

## 1.12 Top three HEI – Capacity building

The panel was very much impressed by the many outstanding activities covered by the 39 Linnaeus centres in the various HEI. Some highlights of scientific excellence and societal relevance will be given in Chapter 3 and 4.

Clearly the evaluation committee cannot come up with a research ranking of the Swedish universities based solely on the Linnaeus program. However, the focus of the evaluation as described in Chapter 4 was to provide evidence of the merits (or lack thereof) of establishing sustainable Centres of Excellence for enhancing and focusing research efforts at the universities in Sweden, in order to increase the international visibility of Sweden as a research nation.

In this context the following aspects played an important role in identifying best practice in HEI, keeping the intention of the Linnaeus program in mind. These were, for example, the successful build up and close down or continuation of Linnaeus centres, the management and leadership of CoEs, recruitment processes, knowledge transfer between subject areas, and between senior and junior scientists as well as the renewal of a CoE's research profile.

In addition, the panel looked at the use of the CoE investment by the University for profiling and enhancing the international visibility, including support functions, management issues and reflecting the University's research portfolio.

### **Nominations**

Understandably, the evaluation panel had some difficulty in identifying the most convincing case studies with respect to building capacity at their University from the many excellent groups summarised above. The following three HEI were considered exemplary in this category as good examples for making best use of the intention of the Linnaeus program:

**Umeå:** The key step, with respect to the Linnaeus program at Umeå, was that the University grasped the opportunity of doing something novel and positive with the money. The university helped enable the development of the centres, and its leadership was involved from the beginning, carrying out triage to ensure the most

worthy University groups were considered in the initial competition, through to the Rector/VR chairing the internal advisory boards. International recruitment led to the appointment of several outstanding early career scientists, including one of the pioneers of CRISPR/cas gene-editing. Both Centres were highly successful in integrating various disciplines and transformed into permanent institutions after the end of the Linnaeus programs. The Centre for Demographic Research and Aging (ALC) ensured the maintenance and further use of significant data collections and is Swedish host of the prestigious Survey of Health, Aging and Retirement (SHARE). Both Umeå centres had a well worked out scientific program, and they never took their eye off the need for sustainable evolution of each centre. This bio-tech development is now respected across Sweden and the Nordic EMBL partnership in molecular biology is also based at Umeå.

**Linköping:** The university had close connections with and strong support for all three Centres of Excellence. They were monitored by the central University's research structures (in the form of an Advisory Board), but their executive function was independent. From the outset, the University took a strategic approach to the Linnaeus funding call, recognizing the need for strong research environments, and carrying out an internal competition with a good final success rate of c. 40 percent of applications funded. It also added matched funding and other incentives. The resulting long-term funding was very valuable to the academics directly involved because it provided freedom to do curiosity-driven research and accelerated their research progress while the stability and continuity allowed risk-taking. LiLi-NFM (Novel Functional Materials) was the first big Centre, bringing together a synergistic multidisciplinary group, which, to quote a remark made during our evaluation, "crystallized into a beautiful shape". The Linnaeus Centres at Linköping have left a strong legacy, morphing into Centres with other funding, and having a strong and dynamic impact on society and industry.

**Uppsala:** The Linnaeus program had a catalytic impact upon the research governance and structure within the University stimulated by the failure to obtain significant funding in the first round. The Vice-Chancellor reported that the University instituted an internal research assessment exercise to better understand their strengths and revised their internal bidding processes. This directly contributed to the institution's improved success rate in the second round. All the Centres have been embedded into the general structure of the University and connected to education through various teaching and training programs. Early on the UU established a set of policies for the organization and management of research units and Centres from which the Linnaeus Centres have benefitted. This has ensured strong leadership with good administrative capability and an open culture. The program also stimulated the University to think strategically around creating interdisciplinary clusters focusing on key challenges and to initiate a set of staff development programs for research leaders.

The Linnaeus mission, fostering centres of excellence and bringing together a critical mass of researchers crossing disciplinary boundaries to explore common

research goals, has had a direct and significant impact upon the system of research governance within UU with the value added from the scheme going well beyond the four funded Centres, driving change throughout the institution.

In addition to the above-mentioned top three HEI, the panel wants to highlight the performance of the **Swedish University of Agriculture (SLU)**: although having only one Linnaeus Centre, SLU has managed to transform itself into a highly visible, specialised university and has become, also with the help of Linnaeus Funds, a world class research institution on insect biology with excellent international ties. The panel much appreciated the vision driving this transformation, the governance model with a rotating leadership and appropriate training, the international recruitment, the organized joint co-supervision of researchers, inspiring collaboration instruments like the 'Lighthouse Project', the emphasis on societal impact and the launching of alumni in academia, industry and government agencies. This culminated in the creation in 2020 of the first Max Planck centre in Scandinavia.

## 2. Research performance of the Linnaeus Centres

The following chapter presents a short overall joint assessment of the Linnaeus centres as already discussed in more detail in Chapter 4. This chapter is not about which Centre is better in terms of science than others. The panel was very impressed by the overall quality of all the Linnaeus centres.

Instead, the panel tried to evaluate the various Linnaeus centres based on the following criteria:

- High scientific quality of research at the centre,
- Breakthrough/high risk-high gain research present at the centre,
- Interdisciplinary research endeavours present at the centre,
- National and international research collaborations and
- International recognition in the international research community.

The judgement of the panel was also based on material provided in written form such as bibliometric reports, peer reviews of publications and scientific case studies for each Linnaeus centre. In addition, the panel had some background information from previous evaluations on the performance of the Linnaeus centres after two years of funding, and at the mid-term of the program period. However, clearly the hearings gave some additional insight.

The assessment is divided into topical subfields, namely natural sciences, engineering sciences, medical sciences and humanities and social sciences. In each of the subfields three examples of very convincing Linnaeus centres in the above mentioned spirit are listed.

### 2.1 Natural Sciences

The research areas of the ten Linnaeus Centres in the field of natural sciences covered a wide span of topics from animal migration, to astroparticle physics, climate change, insect ecology, marine biology, use of lasers in various applications, as well as quantum and molecular systems. The Centres were built on existing expertise at the host institutions and some of them were already world-famous, whereas others were born as a result of Linnaeus funding.

The research performance of the ten Linnaeus Centres in the field of natural sciences ranged overall from very good to excellent. In general, the natural sciences Linnaeus centres outperformed other research of the host institutions. Throughout the field the scientific performance improved, which is important for the competitiveness of Swedish natural sciences during a time when the competition in particular from Asia is increasing.

All Centres in natural sciences pointed to the role of Linnaeus long-term funding in allowing them to conduct high risk – high gain research. A concrete example of this is given below as the highlight of LinneQS.

### Top three centres

Several Centres were considered in the selection of the top three centres and the differences between six or seven top candidates were small. The sub-panel took into account several criteria. In addition to bibliometrics, referee reports of articles submitted by the Centre and the scientific case studies provided by the Centres, considerable weight was given to the transformative effect of Linnaeus funding, which became more evident during the final interviews. The top three Centres were found to be, in alphabetical order:

- Insect Ecology, Ethology, and Evolution (ICE3) of the Swedish University of Agricultural Sciences (SLU)
- Linnaeus Centre on Engineered Quantum Systems (LinneQS) of Chalmers Technical University (CTH)
- Oscar Klein Centre for Cosmoparticle Physics (OKC) of Stockholm University (SU)

**ICE3** was the only Linnaeus centre at SLU. Their demonstration of effects of volatiles on herbivore-threatened plants is novel, as are several other findings on insect chemical ecology. The submitted science case study on the behavioural and neurophysiological modulation in a moth was well-written and convincing. As the centre did not have much history before the Linnaeus program, their scientific output is not as large as the output of some other Centres but their citation record is excellent. Also, the peer-reviews of the papers submitted were excellent. The research is interdisciplinary and clearly of the high risk – high gain type. The centre has achieved great international recognition, the most recent being the establishment of a new Max-Planck-Centre at SLU co-funded by Sweden and the Max Planck Society. This was actually announced during the panel evaluation week! ICE3 is an excellent example of the difference that the long-term Linnaeus funding has made.

**LinneQS** was based on previous solid high-class research on quantum physics and technology at CTH. Their most impressive scientific achievement was the demonstration of the dynamical Casimir effect that was predicted 40 years earlier. It was ranked by Physics World as the fifth most important discovery in physics in 2011. This was a prime example of how the Linnaeus funding facilitated high risk – high gain research because a previous funding application for the project had been turned down, being assessed as too risky. During the Linnaeus period the number of publications of the Centre has doubled. Overall the scientific quality of research results is excellent as shown by the bibliometrics and the peer-reviews of the submitted articles. As a summary, LinneQS researchers have a clear breakthrough mentality. They publish in the best journals and collaborate with the best scientists abroad.

**OKC** was already a very strong research environment before the Linnaeus program and is presently one of the leading centres world-wide in the field of

fundamental astroparticle physics. The submitted scientific case study on multi-messenger astrophysics including the newly-opened gravitational wave window to the universe is very compelling and well-written. Overall, the research of OKC is oriented towards the most challenging questions both in astronomy and elemental particle physics. As the energies of cosmic particles hitting the Earth will not be possible to obtain in terrestrial accelerators, astroparticle physics may become the most important experimental tool in the quest for fundamental understanding of the structure of matter in the universe. Consequently, also the research has a strong flavour of high risk – high gain. During the Linnaeus funding period the already very high scientific productivity of the centre has increased by a factor of 2 to 3. The bibliometry is excellent, being 2.1 times the average for top 10 percent publications. The centre is well-known internationally and has a very wide and strong international network.

## 2.2 Engineering Sciences

In the Linnaeus program, eight Centres were funded that dealt primarily with engineering sciences. The evaluation of the performance of these centres was generally very good to excellent, with regard to all considered criteria. The Linnaeus program philosophy therefore appears very well suited to the field of engineering sciences, having clearly boosted scientific production, interdisciplinarity, and internationalization of the main Swedish actors in the field.

### **Top three centres**

Although all Centres had positive achievements, the panel considered that three Centres clearly stood out, providing an excellent performance and leveraging the grant into an outstanding and lasting scientific legacy. These are the following:

#### ***ACCESS***

*ACCESS* was a very successful centre with a very high quality of scientific outputs, as witnessed by the increasing publication fractions and citations that were well above average and a large and increasing rate of publishing papers among the most cited in the field. The Centre has achieved high visibility and a strong brand model that aided the launch of new interdisciplinary collaborations, provided strong support to junior researchers, and served as a catalyst for national and international collaborations with leading universities in the world. The centre members have attracted many prestigious and substantial external funding grants and received prestigious international prizes. After the end of the Linnaeus grant, the centre has evolved and transformed itself into a new initiative to address the wider objectives of digitalization of the Swedish society. The efforts funded by the Linnaeus grant were an essential precursor to the formation of the new initiative.

*ACCESS*'s approach to the implementation of the Linnaeus Centre strategy can be considered to be exemplary. A very strong identity was established from the beginning, with the help of professional branding, and funds were used to attract

established visiting professors and open postdoc positions that were attractive in the international competitive environment. The centre grew substantially and reached levels of international excellence and critical mass, establishing itself as one of the leading centres on the global scale.

### ***FLOW***

The research activities of FLOW were concentrated on boundary layer flow analysis and simulation, with implications for drag reduction, increasing wing lift, heat and mass transfer applications etc.

The quality of the scientific output of the centre has been characterized by excellent bibliometric statistics, a growing number of publications and high citation rates. With their publications, up to 10 percent papers of them figured in the top 1 percent of their field. Evidence of interdisciplinary research is provided by reports and publications, e.g. a notable paper in *Nature Communications*. The collaboration connection graph and the authorship of published papers and reports provides a good measure of intensity of external and international collaborations, adding up to a high international visibility. Other manifestations of quality include facts such as the most downloaded paper in *ACS Nano* in 2018, and the scientific case study that was provided, which highlights the importance of the centre's scientific work.

### ***NanoQE***

NanoQE is an example of the successful synergistic combination of two strong existing research groupings, initiated by the University prior to proposal submission. NanoQE provided the opportunity to bring leading theoretical expertise in nanoscience together with strong experimental activities around the world-leading fabrication and characterization of high-quality nanowires. The formation of the centre resulted in a very visible and internationally competitive grouping with a broad coverage of topics within nanoscience and technology. This has led to considerable success in coordinating EU programs, the development of strong international partnerships and in attracting SRA and other substantial follow-on national funding, all of which serves to retain the high international visibility and collaborative nature of the Centre. The legacy of NanoQE can be considered to be "NanoLund", the centre for nanoscience at Lund University that continues to support and coordinate activities within nanoscience and nanotechnology. Outstanding peer reviews and a number of influential papers with very high citation rates and many publications in the top 10 percent demonstrate the breakthrough nature of the results of NanoQE. The importance of the interdisciplinary nature of the research carried out within the Linnaeus Centre was clearly apparent in the emergence of new research areas and the large number of new collaborative constellations that developed throughout the centre lifetime.

## **2.3 Medical Sciences**

The scientific excellence of the Linnaeus Centres in medicine is very high. Examples include Bagadilico (LU) developing novel understanding of the diagnosis

of diseases of the basal ganglia, most notably Parkinson's and Huntington's diseases. CRrisP (KI) addressed very clearly set goals to reduce mortality of breast and prostate cancer through individual prevention programs based on identifying individuals at high risk. DBRM (KI) provided new concepts of stem cell differentiation as well as being in the forefront of development of single cell RNA-Seq techniques. Hemato-Linné (LU) provided interesting results on how the regulation of normal and leukaemic haematopoietic stem cells is governed and how blood lineage development is determined through molecular switches in these cells and their progeny. NRC (LU) presented a highly original approach to developing a brain-machine interface for research on neuronal mechanisms. Research at TARGET (KI) led to the development of novel diagnostic, prognostic and therapeutic tools based on new understanding on the biology of tumour fibroblasts and pericytes. Using novel radiocarbon dating of tissues, THRM (KI) identified turnover of cells in adult human tissues thought not to be subject to renewal such as the brain and cardiocytes in the heart.

### **Top three centres**

Here, we highlight in more detail three best practical examples of research excellence in the same sense as above for natural science and engineering science.

#### ***CERIC***

This Centre was built on existing, strong research in inflammatory mediators, autoimmunity, chronic inflammatory diseases, and cardiovascular disease at KI. The goal has been to study why chronic inflammation sometimes, but not always, results in increased atherosclerosis and leads to myocardial infarction or stroke, and to identify novel therapy targets against chronic inflammatory diseases and cardiovascular disease (CVD). An important goal is tools and practices for preventive management of arthritis.

They have been highly productive with many top-level publications. Their bibliometric parameters are outstanding including a mean citation rate of about 1.7 and a top 10 percent share of over 0.2. Peer evaluation of their top 8 publications gives excellent results. The peer review notes high originality and potential for therapeutic implications. The level of national and international collaboration is impressive.

The centre is characterized by efficient use of patient materials and data combined with biomedical expertise, including novel mouse models. Altogether, excellent interdisciplinary work between experimental and clinical research and epidemiology, extending to therapy targets, is evidenced. Studies on the roles of different immune cells in CVD resulted in the identification of mechanisms that promote stabilization of artery walls and on the other hand on how CD4<sup>+</sup> T-cells strongly affect lipid metabolism. Importantly, they identified high-risk genetic determinants that combined with specific environmental factors contribute to the pathogenesis of inflammatory diseases. The centre's work is internationally extremely well recognized.

### ***UCMR***

This Centre is an interdisciplinary research centre established by a consortium of scientists representing medical and molecular microbiology, molecular and structural biology, chemistry and physics, and is devoted to top quality research and novel applications in the fields of microbial pathogenesis. The first and distinguished Director of both MIMS and UCMR (Professor Bernt Eric Uhlin) identified antibiotic resistance at an early stage, and thus the UCMR goal was to develop model systems to identify new control strategies for modern day problems of microbial infections. The evaluation panel judges it as one of "the jewels in the crown" of the Linnaeus Centre system.

The best known of the centre's international recruits appointed in 2008 was Dr Emmanuelle Charpentier who stayed for 7 years. She is one of the pioneers of the use of CRISPR:cas9 for gene editing, publishing key papers in Nature in 2011 and 2012 whilst a member of the centre. The UCMR CRISPR group has done seminal work on the fundamental nature of the CRISPR system, and this is particularly topical, not least given the profound biotechnological impacts of the CRISPR/Cas system in revolutionising aspects of gene engineering in eukaryotic molecular biology. This world-wide interest has, to date, led to >8000 citations of the 2012 paper. Interestingly, this was an entirely new area of research within UCMR, a consequence of international recruitment, and a bottom-up strategy of PI freedom in choosing research topics.

Several of the other group leaders have also done remarkable work on virulence regulation including the chemistry and physics of pili and developments in pilicides, coilicides and the identification of receptor inhibitors. They have also made progress on the biogenesis of membrane vesicles (OMVs) in several bacterial pathogens and their possible roles in virulence factor delivery, immune evasion and as future candidate targets for vaccine development. In line with the prior proof of concept developed by the Umeå researchers on Type III secretion system inhibitors, there are projects on the search for small molecule inhibitors of the Type VI system.

### ***LUDC***

This Centre at LU has a scientific impact that cannot be overestimated. The network has combined various disciplines effectively into a very dynamic, diligent and thoughtful analysis of large patient cohorts, and their detailed molecular, genetic and clinical data. Work had started with large scale genome-wide association studies (GWAS) in very well characterised clinical patient cohorts together with the Broad Institute at MIT. Their publication in Science received the scientific breakthrough of the year considerations by the same journal.

As an example, a variant of the melatonin receptor 1B (MTNR1B) lowers the ability to secrete insulin in about 30 percent of the population. The investigators went as far as administering melatonin in a clinical study to prove this important point. Another risk variant has been identified in ADRA2A gene, again by animal study and human sample analysis. Here adrenalin weakens the stress response in affected individuals. Studies show that the inhibitor yohimbin elevated insulin secretion.

The publication impact has been highly relevant and rose significantly over time. The landmark paper by Emma Ahlqvist and colleagues is a direct outcome of the

collaboration in the network, defining a new sub-classification of diabetes patients into five groups of different disease mechanism and/or severity, has been cited more than 430 times since its publication in May 2018 in *Lancet Diabetes & Endocrinology*. LUDC publications were the most numerous among the Linnaeus centres, with an increase in impact over time. The expert peer review of their top 8 publications led to the highest evaluation scores by one or both experts on most publications that were reviewed.

The scientific success of the Centre of Excellence has developed and it continues to function as a centre of excellence just as intended by the program. Combinations of scientists from the basic sciences, genetics, physiology and biology, epidemiology and bioinformatics have combined with clinical researchers in an exemplary, highly collaborative effort, exhibiting a best practice example of team science both nationally and internationally. It has been especially advantageous that the network has had and further continues to systematically develop its access to large patient and control cohorts.

## 2.4 Humanities and Social Sciences

Nine centres of excellence were funded within the broad area of Humanities and the Social Sciences, ranging from understanding long-run demographic changes in the context of broader social and economic history (CED, Lund), innovative entrepreneurship and knowledge creation (LUCIE, Lund), religion and society (IMPACT, Uppsala), population ageing and well-being in later life (ALC, Umeå), the interplay of cognition, communication and learning (CCL, Lund), through to meeting the challenge of global sustainability (LUCID, Lund).

### Top three centres

Below we discuss three Centres that exemplified best practice in terms of their scientific quality, innovation and contribution to breakthrough interdisciplinary research within the context of their respective fields.

- Social Policy and Family Dynamics in Europe (SPaDE), Stockholm University
- Linnaeus Centre for Research on Hearing and Deafness (HEAD), Linköping University
- Centre for Learning, Interaction, and Mediated Communication in Contemporary Society (LinCS), Gothenburg University
- 

### *SPaDE*

The outstanding scientific significance of the Centre of Social Policy and Family Dynamics in Europe comes from its fourfold contribution. First, it integrated five disciplines which partially share analytical perspectives but have drifted quite apart in recent decades. Second, the Centre advanced what might be called the microanalytic revolution in demography the prior strength of which was its nature as

highly aggregated formal accounting schemes based on census data by focusing on individual and household level transitions and processes in neighbourhood contexts. Third, it developed a unique and quite differentiated data structure combining longitudinal life course data from registers covering the period from 1960 to the present (STAR – Sweden in Time - Activities and Relationships), survey data like the European Gender and Generations Survey, data on small spatial units (GeoSTAR) and an indicator data bank on social policies (SPIN). Fourth, it succeeded in methodologically highly demanding causal analysis on conditions on the uptake of family policies as well as on the socio-demographic consequences of such policies. Although the policy focus was initially on Sweden, especially in regard to parental leave policies, the Centre also systematically achieved relevant cross-national comparisons. These investigations and corresponding publications resulted in high international visibility and recognition.

Moreover, it should be noted that the Centre recruited high calibre senior and junior scientists from abroad (e.g. the US, Spain, Germany and the Netherlands) and effectively worked through expanding the Centre into an international network of research groups. The nomination of an ERC Consolidator Grant to one of its junior researchers is a further reflection of the high scientific value of the Centre.

## ***HEAD***

The Linnaeus Centre for Research on Hearing and Deafness research program has established itself as a world leader in the new and emerging field of cognitive hearing science, shedding light on how hearing-impaired and deaf people deploy cognitive resources to communicate. Its work on the Ease of Language Understanding – ELU model – is recognised as the leading theoretical model within the field and indeed it might be argued that the team have been instrumental in establishing the sub-discipline and putting it on the map.

The team bridging cognitive neuroscience, psychoacoustics, engineering, clinical audiology and linguistics have been highly productive with a clear focus and vision. Their research has been published in the top international peer reviewed journals and the Centre has consistently achieved an above average share of top 10 percent and top 1 percent citations throughout the period. As a result of their ground-breaking research, including the demonstration of the plasticity of the neural correlates of sign language and the role of working memory on low level brainstem response, the team have developed and sustained a strong international network.

A hallmark of their work has been the explicit integration of basic scientific research with applications linked to improving the lives of people with hearing-impairments. As well as publishing in scientific journals the team have taken care to disseminate their findings to the general public. Given the ageing of the population, HEAD's research on the complex links between cognition and hearing loss is extremely topical and of clear societal relevance. HEAD has established strong collaborations with hospitals and audiological centres, stakeholder community organizations, government agencies and industry.

### ***LinCS***

Learning, interacting and communicating with each other is undergoing a transformation as a result of the development and availability of digital tools in our “contemporary society”. By bringing together scientists from across the fields of education, computer science, ICT and library sciences, LinCS achieved major research contribution across four fields: (1) digital media and learning environments in school, (2) digital media in higher education and professional learning, (3) learning, everyday activities and identity in contemporary society, (4) video in research on learning: methodological and theoretical opportunities. Together these have provided the knowledge base for understanding the potential role of technology in transforming teaching, learning and literacy practices, generating new ideas and ways of organizing classroom activities, learning in the workplace and systems of life-long learning, marginalization and learning disabilities, ethnic/social background and learning, and the role of gender in the shaping of school practices. A particular highlight has been the PhD school which has run for over 5 years, benefitting “close to 400 students from across Europe”.

One of the hallmarks of LinCS was the use of a special form of “Collegia” as the base units for research. The four Collegia in “Learning, Literacies and Infrastructures in Digital Environments”, “Learning and Information Technology”, “Socio-Cultural Studies” and the “Politics of Education” brought together research, practice and policy in the form of sustained and regular public seminars. LinCS was able over the period of the Linnaeus funding to secure significant additional funding e.g. from the Knowledge Foundation and the Wallenberg Foundation, ensuring that it continues to be seen as a national centre of excellence.

### 3. Societal relevance of the Linnaeus Centres

The Swedish Research Council mainly funds basic research, whereas other organisations such as Vinnova support innovation and other forms of translation of research findings for the benefit of society. The original Linnaeus Call did not include any prerequisites or criteria for knowledge transfer beyond academia. However, the Swedish Research Council decided to include in the final evaluation of the Linnaeus program an additional part, in which each Linnaeus Centre was asked to describe one case of societal relevance that their research had delivered. The motivation for this addition was the fact that political decision-makers are asking more and more about relevance of basic research, and that ambitious strategies to boost sustainable development such as the United Nations Sustainable Development Goals and the European Union's Green Deal cannot be implemented without new technologies and relevant knowledge. Societies need more than ever research-based knowledge, which can be perceived as a public good as it is created by public funds.

The European Research Council (ERC) has enlarged its portfolio from basic research grants to Proof of Concept grants that enable ERC grantees to bring their research findings closer to the market. This grant can be used for investigation of business opportunities, establishment of intellectual property rights or technical validation of research findings. The European Commission's research program for 2021-2027, Horizon Europe, will focus on innovation much more than the previous programs.

One example is the UK's research excellence framework (REF), which includes societal relevance (termed "impact") as one of the success criteria of research. For the purposes of the REF, impact is defined as an effect on, change or benefit to the economy, society, culture, public policy or services, health, or the environment or quality of life. Impacts are assessed in terms of their 'reach and significance', which means how widely they have an effect, and how significant that effect is. For REF, the link between research and its impacts must be fully documented. The easiest impact to demonstrate is economic gain, such as product development, patents and spin-off companies. Demonstrating beneficial impacts directly on the public is much more difficult, but before and after surveys can be helpful.

The Linnaeus Centres were asked in this final evaluation to describe the reach and significance of their societal relevance cases. The cases the Linnaeus Centres highlighted were very diverse, and the understanding of the concept of "societal relevance" differed widely. This was to be expected, as the definition of the term is in the process of being developed. Nonetheless, the very fact that all the Linnaeus centres could easily demonstrate outstanding examples of "societal relevance", although this criterion was not initially specified, shows the social impact of basic research. This also implies that in future calls for such a funding program no narrow criteria for "societal relevance" should be specified in advance.

### 3.1 Natural Sciences

All first-class research in natural sciences is societally relevant. However, the major societal impact of fundamental research may take a long time, sometimes decades. The analysis of societal relevance of the individual centres was based on the case studies submitted to the panel.

#### Top three centres

The sub-panel wishes to stress that the selected three most societally relevant centres must be understood as particularly good examples among several highly relevant examples. In the selection both the reach and significance of the presented case studies have been considered. The selected centres are, in alphabetical order:

- Centre for Bio-inspired Supramolecular Function and design (SUPRA) of Chalmers Technical University (CTH)
- Lund Laser Centre (LLC) of Lund University (LU)
- Marine Evolutionary Biology (CeMEB) of Gothenburg University (GU)

**SUPRA** has a large number of partners and stakeholders within the biomedical industry, in particular AstraZeneca. The research has led to two spin-off companies with a good potential for more to come. The case study on bio-inspired supramolecular design and analysis for improved drug discovery is very impressive, illustrating both wide reach and great significance.

Fundamental research on lasers has today a wide range of socially relevant applications. From their extensive portfolio **LLC** has selected as their case study the use of laser spectroscopy in scattering media, addressing numerous medical, ecological and environmental issues. This illustrates the wide societal reach with significance varying from very good to excellent.

The societal case study of **CeMeB** which addresses scientific advice for management of marine genetic biodiversity has a more local reach than the two examples above, as it is focused on Swedish coasts. On the other hand, it has a very great significance to national and regional authorities and fishing in the Baltic area. Also It has strong potential for use in other similar marine environments in Europe and elsewhere.

### 3.2 Engineering Sciences

The descriptions provided by the Linnaeus Centres in Engineering of societal relevance and impact were of a rather generic nature. This however should not come as a surprise.

Indeed, the societal relevance of most research activities in engineering is self-evident: The demands from society in general, and industry or government agencies specifically, are very clear with well described expectations from (future) technology. They can be easily translated into objectives for research activities in engineering. Think of telecommunication networks (5G), aerodynamic modelling

and simulation (decreased air resistance leading to reduced emissions and power consumption), materials research (leading to new materials more compatible with environmental and sustainability objectives), technology in health and medicine, etc.

In addition, in engineering, there are many instruments to catalyse societal impact via technology transfer in the form of patents, software licenses, bilateral contracts with industry or the creation of spin-off companies, which all of the Linnaeus Centres in Engineering have deployed in one way or another.

Societal relevance was not an essential objective in the original Linnaeus calls, however, times have changed considerably since then. Nowadays, many research themes in engineering are highly correlated with and deeply rooted in societal challenges in health, industry, mobility, sustainability – a trend that has been captured by all Linnaeus Centres in Engineering.

### **Top three centres**

The sub-panel wishes to stress that the selected three most societally relevant centres must be understood as particularly good examples among several highly relevant examples.

#### ***UPMARC***

The case study that was provided illustrates the potential impact of new ideas and technologies for cache memory management in computers, to which UPMARC contributed. The generation of ten patents, a spin off company and investment by one of the world's largest computer companies provide evidence of the great significance of the research done. The significant reduction of energy spent in locating and moving data, increasing battery life and decreasing environmental impact of computing will have consequences of great relevance to the society as a whole.

#### ***ACCESS***

To illustrate the societal relevance of the research brought about in the centre, ACCESS presented a case study on application of research results to development of several components of new communications infrastructure (5G). This was done in close collaboration with relevant industries (Ericsson and ABB). The contribution of ACCESS is clearly outlined in the case study and in the statement provided by the Head of Research at Ericsson. This collaboration was not directly supported by the Linnaeus program (it was predominantly funded by industry and EU projects) but the Centre clearly provided the seed, facilitated and helped in the coordination and synergy that is apparent from the case study. References have been given to the underlying academic papers from ACCESS. Although no quantification of the actual impact is available, it is fair to say that participation in a European-led initiative to lead the 5G revolution is of paramount importance.

### *NanoQE*

The high-level fundamental science pursued within NanoQE led to the development of IP and the establishment of a number of spin-out companies. The impact case study highlights two of the new companies that were formed during the early years of NanoQE: Glo AB and Sol Voltaics AB, specialising in light-emitting diodes based on nanowires and solar energy applications of nanowires, respectively. The close interaction between leading fundamental research producing high impact journal publications, the awareness of the importance of developing applications with societal relevance, consideration of intellectual property rights and finally the formation of spin-out companies with market-winning product development provide evidence for the significance of the research and high potential societal relevance of the basic research that was carried out within NanoQE. Glo AB moved to Silicon Valley in 2010 to allow for expansion but retained a long-term research collaboration with researchers within NanoQE. Today Glo targets the entire micro-LED display market, from small-sized wearable displays to TV panels and large-area displays.

The close symbiosis between NanoQE activities and Sol Voltaics AB was built on very fundamental developments in understanding and developing efficient growth processes for nanowires. Two orders of magnitude increase in the growth rate was a major scientific breakthrough that also made large scale applications of nanowires for solar energy production feasible. A later NanoQE-Sol Voltaics research collaboration demonstrated a technology breakthrough based on theoretical predictions that drove the development of the nanowire growth and solar cell processing, leading to significant improvement in solar cell performance. Sol Voltaics AB has raised substantial investment sums in recent years and is now close to commercialising their “Solfilm” product, a cost-effective method to significantly enhance the module efficiency of conventional silicon solar cell panels.

### 3.3 Medical Sciences

The centres in the Medical Sciences reported a wide spectrum of societal impact. This included in the case of Bagadilico (LU) excellent progress in translating basic research on multiple sclerosis and Parkinson’s Disease into clinical development, impressive collaboration with established pharma companies and generation of spin-off companies. With respect to CERIC (KI) Swedish arthritis clinics are using knowledge generated by the centre and collaborations with big pharmaceutical companies are in place. DBRM (KI) provides examples of outreach activities including disseminating key concepts of stem cell research to the general public. The pre-clinical work on two genetic disorders at Hemato-Linné (LU) has now the possibility to progress towards clinical trials. NRC (LU) presents a bold project with the intention to develop biocompatible brain-machine interface devices that would allow sophisticated recording and stimulations of neurons, and they have founded a company related to the research outcomes. TARGET (KI) has contributed to changing national, European and American guidelines, which now recommend biopsy-taking of metastatic lesions to improve accuracy of cancer treatment decisions. THRM (KI) has actively communicated to the general public on their

basic research, where using a special approach of radiocarbon dating they show that tissues previously thought not to undergo renewal, particularly brain and heart, contain cells generating new tissue. Here, we highlight in more detail three cases of societal relevance.

### **Top three centres**

The sub-panel wishes to stress that the selected three most societally relevant centres must be understood as particularly good examples among several highly relevant examples.

#### ***UCMR***

Whereas UCMR chose CRISPR:cas9 for its scientific impact, it is a reflection of the breadth and depth of the Centre that it is in the position to choose a different topic for societal relevance. A specific sub-group of adenoviruses can cause severe and lethal infections, notably eye-infections that are estimated to cause suffering in 20-30 million individuals every year. The specific case they identify is the adenovirus-caused ocular infection of conjunctivitis, about which a major paper from the group was published in *Nature Medicine* (2011). The next steps have involved a company, Adenovir Pharma, in successfully developing antiviral drugs against adenovirus-caused epidemic keratoconjunctivitis (EKC) - a severe eye infection.

Just as in the scientific impact case, a specific early-career scientist was recruited as a new group leader shortly after the creation of the Centre, and then supported by postdoc assistants and graduate students who worked on this project. This PI identified sialic acid as a cellular receptor for these conjunctivitis infections. The detective story unfolded through collaboration with an existing faculty member of UCMR, with expertise in organic chemistry, and then with a key structural biology laboratory in Tübingen in Germany. Not only was it a novel approach to target the ligand-binding site of a pathogen, but it turns out that sialic acid may be a "bad guy" in a number of infections. A further twist of the story is that "...fast, specific, and cheap molecular diagnostics that can be implemented at primary health care is crucial for antiviral drug development and drug usage/efficiency." We understand that the pharmaceutical company has had successful phase 1 and phase 2 trials, and the Swedish Research Council should monitor the next steps of efficacious drug development with interest. The understated manner in which this major advance is described reflects the style of the leadership of this group in which scientific advances of societal relevance can speak for themselves.

#### ***LUDC***

Diabetes mellitus has increased to epidemic proportions in societies with a western, sedentary lifestyle and nutritional habits. The work of the LUDC Centre is extremely valuable for developing a more personalized approach to treating individual patients affected by these entities.

The LUDC network has succeeded in developing a refined diabetes classification beyond the classical types 1 and 2. In that modern concept, diabetes mellitus is constituted by at least five new disease subgroups. This paradigm shift has provided insight into new treatment options for the different disease mechanisms, opening

new therapeutic avenues for patients and care optimizing products for industry. As an example, it now is clear that prevention of renal complications should focus on the severely insulin resistant and do it early.

This classification will allow us to focus very targeted approaches to treatment on the most severely affected groups of any population with a high likelihood of developing complications, like the ones in the severe groups (severe autoimmune, insulin deficient /resistant clusters), and will focus more behavioural prevention onto the mild obesity and ageing groups. For the health care system of providers and industry, a number of new therapeutic strategies can now be developed, tested in informative clinical trials, and applied directly or lead to marketable drugs. The network has recently won a major grant from the Strategic Research program for establishing an industrial research Centre for precision medicine in diabetes and is engaged in or leads multiple international academic and industry related trials.

Through the results of the LUDC Centre, the eventual goal of individualized healthcare offering prevention, disease interception, early intervention and outright cure for most or all affected patients has come closer, and promises significant impact on the quality of life of diabetes patients, and thereby a significant reduction of the human suffering. While the costs of treatment might increase at first, through better and more targeted disease control, the LUDC findings should eventually also contribute to reducing the economic burden of the diabetes epidemic for society.

### *CrisP*

Breast cancer will affect about 13 percent of women and 0.1 percent of men in their lifetime. While we still know very little about the actual origin and risk factors for developing this disease, early detection and better therapies have led to significant improvement in survival. Over-inclusive diagnosis and false positive calls have hampered the effectiveness and efficiency of these measures.

The CrisP Centre has chosen a very strategic approach to addressing this important problem for society. The underlying hypothesis has been to identify those women at increased risk of developing the disease and concentrate prevention and early detection resources in this area. The network has constructed three main pillars of activity to drive the translation of medical knowledge into medical usefulness for society.

Firstly, the resources of the Linnaeus network funding have first and foremost been used to create Karma, a large cohort of women with breast cancer. The Karma cohort started recruiting in 2010, and within three years already had more than 70,000 consented participants for sample, image and data donation. The Centre also carries data management and other maintenance duties of this important installation.

Secondly, CrisP has sought to identify molecular risk groups by genotyping and genome wide association studies (GWAS). To date, more than 16,000 women of the Karma cohort have been genotyped. The network has been able to identify 41 genetic risk loci in the genome that define approximately 5 percent of patients with a familial risk of developing breast cancer early in life. These data have been vetted and contributed to the international Breast Cancer Association Consortium (BCAC) in Cambridge, the largest data set contributed to a number of landmark publications, which allow staff to individualize and focus personalized prevention efforts on families with an increased risk of breast cancer.

Thirdly, CrisP has focused on improving the shortcomings of mammography for the early detection of breast cancer. Especially for women with very dense breast tissue, the sensitivity of detecting early cancers is much too low, missing more than half of all cancers, even though the risk of developing a cancer is especially large in that group. A risk model taking into account this as well as other dominant risk factors (BMI, hormone replacement therapy, alcohol and tobacco use) has been developed for further focusing screening and adjusting screening methodology for women at high risk. In collaboration with an industry partner, the more than 2 million mammography images collected by Karma are currently being used to develop artificial intelligence image analysis features. Such technologies might allow us to improve and distribute the ability of performing high-quality mammography screening throughout the medical system, and thus democratize high quality prevention in this field.

The combined CrisP strategy has been of very significant impact for ongoing research, but also for the approaches to breast cancer prevention in the medical system already today. The focus on the risk and particularly on familial clusters of breast cancer is vitally important for understanding what we now know are many different types of breast cancer, and the personalized strategies required for them. The CrisP CoE with its Karma cohort is a very significant installation of long-standing societal importance and has created the groundwork for further important developments in the future.

### 3.4 Humanities and Social Sciences

Research within the Humanities and the Social Sciences makes a significant contribution to understanding society and human relations and to improving the quality of life. The sub-panel wishes to stress that the selected three most societally relevant centres must be understood as particularly good examples among several highly relevant examples.

#### **Top three centres**

##### ***HEAD***

Fundamental research within the Linnaeus Centre for Research on Hearing and Deafness (HEAD) at Linköping University shed light on the way in which the brain signal processing associated with the use of conventional hearing aids could be potentially linked to negative cognitive performance. This finding stimulated the idea of developing cognitive-friendly hearing aids that would consume fewer working memory resources. Given the link between dementia and hearing loss, such a device could support the maintenance of communication amongst older people with dementia as well as benefitting the hearing impaired more generally.

The HEAD research team subsequently developed a technology transfer partnership with Oticon R&D (Eriksholm), and in 2012 the hearing aid manufacturer Oticon/Demant introduced BrainHearing™ technology into their products – realising the ambition of “cognition-friendly” hearing aids. Today more than 10 million hearing aid users are estimated to be equipped with BrainHearing™

technology. BrainHearing™ is seen as the leading audiological software in the market for producing hearing systems that aid the brain to make sense of sounds with less effort.

### ***SPADE***

From its very conception the Centre for Social Policy and Family Dynamics in Europe (SPADE) pursued a strategy of combining cutting-edge basic research with very applied interests, especially in regard to the conditions and consequences of family leave policies (e.g. career penalties), but also in regard to issues of gender equality, migration, family instability, segregation and poverty. Research findings have been the basis for numerous government and inter-government reports and have been disseminated widely to professional non-academic audiences. What is, however, unique for SPADE is that it actually succeeded in having Centre members either working both in academia and government or only in government and by being very practically involved in the evaluation and redesigning of policies. Moreover, the Centre was engaged in policy transfer into other countries and in very effective engagement and exchange with stakeholder through its founding and very active role in Population Europe, a virtual policy think tank. The dominant role of the Centre in the EU 7th Framework project “Families and Societies” is a further aspect of its leading role in regard to both the academic and policy contributions.

### ***LinCS***

LinCS research on how people access information has informed the organisation of ‘learning’, as broadly defined, ranging from formal education in schools through to continuous professional development amongst health professionals. Virtual environments provide new opportunities of learning at school and in working life. Taking three examples: First, research within LinCS in collaboration with Stanford University has evidenced how a carbon footprint calculator can be used as a resource within the classroom to enrich environmental education, providing students with a visual tool to explore alternative scenarios. Second, research has shown how teaching within dentistry can be improved through the use of digital media. Finally, with Turku University, LinCS have confirmed the added value of the use of virtual microscopes in pathology and in basic medical training. This wide range of relevant fields of applications demonstrates the strong commitment of LinCS to ensuring their research has societal relevance.

## 4. International competitiveness and visibility of the HEI's in Sweden

Although the level of funding obtained within the Linnaeus program for individual Centres was relatively small compared with other external funding programs, the long-term and flexible nature of the funding provided an important impetus to the enhancement of the national and international competitiveness and visibility of the Swedish HEIs that participated in the program. The program has clearly stimulated a long-term change in the way that the majority of HEIs and individual researchers approach internal collaboration, leading to a more strategic planning and enhanced synergy within the individual institutions.

### 4.1 Scientific quality

Many of the Linnaeus Centres grew out of already successful research groupings with high national and international profiles. In these cases the main impact of the Linnaeus funding was to provide the long-term stability and flexibility to engage in more high-risk research and the possibility of retaining excellent early career researchers by offering them a supportive environment and providing access to facilities that may not otherwise have been available to them. One excellent example of the former is the use of Linnaeus Centre funding in LinneQS to support a high-risk project that had been rejected by the Research Council but thanks to the Linnaeus support, produced a high impact publication in *Nature* that generated considerable scientific and media interest and was listed by *Physics World* as the 5th most important discovery in physics for 2011. Many examples of the increase in scientific quality via the recruitment and retention of excellent early career scientists were apparent. The parallel funding of a research school for some Linnaeus centres in the first call was extremely important for attracting excellent PhD students from around the world and providing the resources for developing attractive new interdisciplinary graduate courses. There are a number of examples of these early career researchers (those appointed both as PhD students and as postdoctoral researchers) developing high level independent research programs within the centres, attracting prestigious external funding such as ERC grants and progressing to leadership positions by the end of the funding period. This has contributed to a renewal of the scientific landscape in Sweden and in many cases also to a step-change in the quality and impact of the research that is being carried out.

Other examples of successful Linnaeus Centres involved the coming together of new, interdisciplinary research constellations, sometimes as a consequence of input from the HEI prior to proposal submission (e.g. NanoQE, IMPACT). This provided new synergy and the impetus for developing new interdisciplinary research directions that provided added value and a higher visibility and impact for the research activities at the HEI than would otherwise have been the case.

An important factor that underpins the scientific quality of the centres is the high level of research infrastructure available in Sweden. It will be essential to retain this

high level, including the provision of technical support to make the most efficient use of the investments, if the Swedish HEIs are to retain their currently high international standing.

## 4.2 Profiling

The extent to which the Linnaeus program has contributed to profiling varies across the HEIs. The impact is most apparent at the smaller institutions. A good example is Umeå University where the Linnaeus centres have evolved into priority research domains. At KTH, the FLOW Linnaeus centre provided the basis for a new divisional unit with increased visibility at the institutional level. The success of ACCESS has allowed the formation of a new environment expanded to include new application areas with an increase in associated faculty members. The impact is less noticeable at some of the larger HEI where the Linnaeus Centres were just a few of many “centres” and where later funding initiatives (e.g. SRA, Wallenberg) have perhaps had more influence. However, it should be noted that many of the successful applications to these newer programs were developed on the basis of successful activities supported by the Linnaeus program. It was apparent to the panel that the Linnaeus program has had a noticeable effect on the attitude of HEIs and individual researchers to national collaboration. The introduction of the Linnaeus Centres highlighted areas of excellence to HEI leadership, providing them with the opportunity, based on external peer review, to introduce a more strategic approach to profiling. Unfortunately, the impact that this initiative may have had on profiling the Swedish research environment was greatly reduced by only having two funding rounds for the program.

It is apparent that some of the Linnaeus Centres live on in spirit and have formed a strong basis for SRAs, on occasion merging two Linnaeus Centres from different HEIs. In other examples, the research priorities have naturally evolved leading to the original Linnaeus Centre constellation branching into other new research areas with different collaborations. Although the majority of the Linnaeus Centres were based in one HEI, there were two very good examples of the benefits of cross-institutional collaboration bringing added value (LinCS at GU/Borås and THRM at KI/Uppsala).

The panel had the impression that the HEIs did not make the best use of the prestigious nature of the Linnaeus Centres of Excellence in their branding. The effect was diluted by the tendency for many “centres” at most institutions and the vagueness of the definition of a “centre”.

## 4.3 International visibility

There is very strong evidence that the investment in the Linnaeus centres served to enhance the international visibility of the research being carried out at the HEIs. This was apparent in the increase in high level international applications for PhD and postdoctoral positions and the increased attractiveness of Swedish research activities at the international level. The new collaboration between SLU (ICE3) and the Max Planck Institute and the Umeå partnership with EMBL (UCEG) are two excellent examples of this. Further evidence was the increasing number of ERC grant holders choosing to work in Linnaeus research environments. The Linnaeus

program funding was used in many cases to enhance the international visibility through the sponsorship of international workshops and conferences, some of which have developed into regular international conference series. In some cases, the funding was used strategically to develop specific international research partnerships that opened up new areas of research or to invite guest professors who could bring additional, complementary expertise to the centre activities. A relatively small amount of funding allocated for international networking activities provided a significant boost to the visibility of the centres. The large number of excellent international PhD students and postdoctoral researchers attracted to Sweden by the Linnaeus Centres provided enhanced international networks and opportunities for international research collaborations on the occasions when they moved on to positions outside Sweden after their temporary contracts ended.

The flexible nature of the Linnaeus funding was very important to allow the various centres to prioritise the activities that were most appropriate for them in terms of enhancing scientific quality and international visibility. There was no overarching strategy apparent on behalf of the individual HEIs, nor does there seem to have been any concerted effort to exchange experiences and examples of best practice between the centres.

## 5. Sweden's international position in promoting excellence in science

The Linnaeus program has increased global visibility of Swedish research through a number of outputs. Scientific impact is based on the talent of individual scientists who create world-class science, and on other elements such as international and diverse faculty, critical mass of researchers, research environments with modern instrumentation, possibilities to take advantage of multidisciplinary and to raise the ambition level of the research questions to embrace risky projects.

In the case of all Linnaeus Centres, the quality of the research according to bibliometric analysis is higher, on average, than that of their host university's overall output. In many cases the share of top 10 percent publications is 2-3 times higher than the world average in the respective fields. Several Centres have had breakthrough findings and have succeeded in highly competitive international calls, such as the ERC. The awardees of the ERC Starting Grant program are regarded as the stars of the next researcher generation, sought after by the best universities worldwide.

One of the enabling factors of scientific success is the diversity of the researcher community. Diversity at the levels of scientific field, career age, gender, as well as national and cultural backgrounds increases collective intelligence and brings in new ideas, topics and methods. The most fundamental level of diversity, gender, is well in place in most of the Linnaeus Centres, while some struggle with too few female researchers especially at the top level. The Linnaeus grant has been instrumental and very successful in internationalization of the Swedish researcher base. Most Centres were able to recruit PhD candidates and postdoctoral researchers from abroad. Several of the recruits have become academic leaders in Swedish universities, though the Panel also encountered international successful young recruits, whose career opportunities after the closure of their Linnaeus Centre appeared to have stagnated in the Swedish academic career system.

Many former faculty of the Linnaeus centres have been recruited abroad. With their current international networks they now multiply their Swedish colleagues' networks, thereby contributing to the strengthening of Sweden's position as a research nation.

All of the Linnaeus Centres have lifted training of the next generation of researchers to centre stage of their activities by recruiting PhD candidates, postdocs and young principal investigators openly and internationally, and by providing them training in research schools, workshops, seminars and retreats, mentoring and support for career development. This is an invaluable legacy of the Linnaeus program, an investment for the future of Swedish science.

Traditional project funding targeted to individual principal investigators usually is provided for 3-4 years. The short duration of such grants guides the awardees to avoid risky bold research topics. The 10-year duration of the Linnaeus grant has allowed high gain/high risk research that is the enabler of ground-breaking discoveries.

Frontier research is dependent on availability of state-of-the-art research infrastructure, instruments and equipment and highly trained personnel who use the facilities, maintain them and support the researchers in using the instruments, and are responsible for data management. The Linnaeus grant has enabled the centres to purchase expensive instruments, build modern facilities and offer high-quality services, often with co-funding from the host universities. In many cases the facilities provide open access to the Swedish research community at large. Research infrastructures are long-term investments and thereby represent yet another legacy of the Linnaeus program to the Swedish university ecosystem.

Sweden is a member state of a number of European research infrastructures that have been initiated by the European Strategic Forum for Research Infrastructures (ESFRI). Sweden is also a member of many large European research infrastructures with cutting-edge facilities that individual countries alone are unable to pay for and host, such as CERN, European Molecular Biology Laboratory (EMBL), European Southern Observatory (ESO) and European Space Agency (ESA). The Linnaeus Centres' researchers have been an important user group of these facilities, as well as coordinators of some of their projects. The activities in these institutes and the ESFRI facilities enlarge the Swedish researchers' international networks, raise the quality of their research and increase the visibility in Europe of Swedish research. Thereby the Linnaeus community has contributed to justifying these organizations' membership fees, which represent an important share of Sweden's research infrastructure costs.

The European Commission recently launched a new competitive program, the European Universities initiative, for universities to form consortia focusing on inter-university teaching and research programs. Several Linnaeus universities have become members of these consortia, integrating Sweden into the European university network. No doubt the accomplishments of the Linnaeus Centres have contributed to this success.

The Linnaeus Centres, though in many cases placed within individual Faculties or Departments in their host Universities, have enabled inter-disciplinary research activities and crossing borders of research fields and the University's internal structures. Though the Centres interacted and collaborated extensively with researchers beyond their Centre, interactions between the Linnaeus Centres within single Universities and between Universities were rare.

The Centres did not stimulate the host Universities to update their structures, except in rare cases where the Linnaeus Centres were used as a model to organize Centres designated by the University itself. The Linnaeus Centres' research fields represented the strongest scientific fields of the host Universities. Nevertheless, the majority of the Universities did not wish to profile themselves according to those strong research fields. Therefore, the Linnaeus Centres' research fields do not feature in those Universities' strategies, and several Universities even lack a research strategy. However, some Universities had included the Linnaeus Centres' facilities in their research infrastructure strategies. The Linnaeus program no doubt has had a positive effect on the Universities' capacity to build and host units such as the Linnaeus Centres, however, this added value appeared to be stronger amongst the smaller rather than the larger Universities.

Most of the host Universities as institutions have not used their Linnaeus Centres' success for branding. The Universities' leadership had entrusted the communication of the scientific output to individual researchers of the Centres. The Panel felt this was a lost opportunity to highlight internationally Sweden's research policy and funding instruments that enabled the establishment of a successful excellence program with an unusually long term of 10 years enabling break through research.

Along with Sweden, other European countries have established Centre of Excellence programs in order to enable world-class science and position themselves as successful research nations. We wish to highlight the basic characteristics of three of them, the Centre of Excellence program of Finland and Denmark, and the Excellence Initiative of Germany.

The Academy of Finland – the Finnish Research Council has run a CoE program since 1995. The program was renewed in 2016 to widen access also to the younger generation of researchers. The CoEs have to be close to, or already at, the cutting-edge of science. They carve out new avenues for research, develop research infrastructures and creative research environments, promote multi-disciplinary research and train new talented researchers. The duration was extended from six to eight years to enable high-risk research. The CoE has to have joint, clearly defined research objectives and run under a joint management consisting of a director, vice-director and team leaders. The calls are for fundamental research in any area, but a CoE has to be co-financed by its host institution (University or Research Institute), and support its relevant strategic priorities.

The Danish National Research Fund (DNRF) runs a successful initiative for Centres of Excellence since more than 25 years. At present, there are some 30 Centres active, in a wide variety of disciplines from humanities, engineering, sciences and medicine.

There is a regular call every two years, open to all disciplines, in which proposals are evaluated in a two-step review process, with international reviewers, and for the pre-selected ones, an oral interview for the Board of the DNRF, who defines the ultimate selection. Criteria include proven record, level of ambition for ground-breaking research benchmarked internationally, outstanding and visionary leadership and the capacity to form a real network, a joint 'physical' community. Funding is absolutely top and provides budgetary critical mass to achieve the objectives and goals as determined in the proposals and contracts. Centres are being monitored annually by regular visits of international Board Members.

The German Universities excellence initiative was started in 2005, following negotiations between the federal government and German states. It was designed to strengthen research at German universities and enhance their global appeal. Since 2019 it continues as an Excellence Strategy with two funding lines:

Clusters of Excellence for project-based funding: Presently 57 Clusters of Excellence are supported for 7 years and a second funding period of another 7 years is possible.

Universities of Excellence: Here 11 universities are funded as individual institutions or as university consortia again for a duration of 7 years with a permanent extension possible.

In summary, the excellence programs of Sweden, Germany, Denmark and Finland share many fundamental features. The Linnaeus program appears to

distinguish itself from the others with its exceptionally long duration, lack of obligation for the CoE to comply with its host institution's strategy and lack of pre-determined co-financing obligations by the host institution.

The Linnaeus program, due to its focus on fundamental research, flexibility concerning the choices on where to target the money, and its ten years duration, has enabled the building of successful research environments. The Centres have achieved breakthrough research, trained a highly-skilled new generation of researchers and developed sustainable research environments that have strengthened the position of Sweden as one of the leading research nations in Europe.

## 6. Conclusions and recommendations for future CoE programmes

The evaluation panel applauds both the Swedish Research Council and Formas for the establishment of Centres of Excellence, known as Linnaeus Centres. The panel was very much impressed by the overall performance of this program and was more than glad to provide feedback and learning to the Government, the research funding bodies and the HEIs regarding the experience and effects of the Linnaeus grant, as outlined in more detail in Chapters 1-5.

### Conclusions:

The following aspects of the CoE initiative were considered as very important and key for the success of the Linnaeus program:

Linnaeus funding was long-term: the ten-year duration allowed researchers to conduct high risk-high gain research. Traditional project funding targeted to individual principal investigators usually is provided for 3-4 years. The short duration of such grants guide the awardees to avoid risky, bold new ideas. In contrast, the 10-year duration of the Linnaeus grant enables breakthrough projects.

Linnaeus centres were catalysts: Some centres started with pockets of excellence spread out between different centres. Linnaeus funding was the catalyst or glue that brought them together. Physical proximity of researchers had major benefits, and the result was a highly international activity. The Linnaeus funding was also a catalyst to increase the level of cohesion in groups, expand existing strengths and supporting interdisciplinary research.

Linnaeus funding was flexible: this was key and allowed the researchers to pick up their own hot topics, in general in a “bottom-up” approach. In some cases, not always, a triage process was created by the University leadership at the outset for selecting the best potential applicants and the promise of co-funding to the applicants.

Linnaeus recruitment was strongly international: Most of the Centres successfully utilized the Linnaeus funding to attract internationally excellent PhD and post-doctoral students, fostering a culture of collaboration and knowledge exchange through seminars, workshops and international colloquia. In this respect the parallel funding of a research school for some Linnaeus Centres in the first call was extremely important.

Linnaeus Centres were “oil and glue”: although the level of funding within the Linnaeus program for individual centres was relatively small compared with other external funding programs, the long-term and flexible nature of the funding provided an important impetus to the Swedish science system in terms of renewal.

Linnaeus centres had snowball effects: the funding often snowballed into larger research activities supported by SRA and foundations like the Wallenberg Foundation, leveraging the grant into an outstanding and lasting scientific legacy. It was also important in developing a model of university-level infrastructure funding.

In addition, the panel made the following observations that could be summarized under lessons learned:

- The program has not really contributed to profiling the HEIs. Here the positive impact was most apparent at the smaller institutions. The vast majority of the universities do not wish to profile themselves according to their strong research fields. Therefore, the Linnaeus Centres' research fields do not feature explicitly in those universities' research strategies, should a research strategy even exist. As a consequence, in only a few cases were Linnaeus Centres transformative in terms of processes and culture of research. Increasing the visibility was largely left to the Centres themselves.
- The required co-funding from the HEIs was not clearly defined. Therefore universities, instead of cash contributions, often used in-kind contributions to support the Linnaeus Centres or just the overhead that came with the Linnaeus funding.
- The Linnaeus Funding was distributed over 40 Centres of Excellence. Given the overall budget, the panel considered this as an already large number. Therefore, a good balance has to be found between the number of Centres and the funding per Centre; in any case the funding per Centre should not become sub-critical.
- Only few cross-institutional collaborations took place, most often when Linnaeus Centres were based in one HEI. Activities between Centres at different host Universities were rare. There was no overarching strategy apparent on behalf of the individual HEIs, nor does there seem to have been any concerted effort to exchange experiences and examples of best practice between the centres or the HEIs.

In summary, the panel got the impression that the Linnaeus Program has played an important role in the funding landscape of the Swedish science system. It was established in 2005 to fill a gap in the funding instruments of the SRC in order to support excellent research in emerging fields on a longer time scale and thereby trigger new research directions in the HEI through the establishment of so-called Centres of Excellence (CoE). These arguments are still valid today as the HEI have to go permanently through a process of renewal.

### **Recommendations:**

Based on the great success of the Linnaeus Program in the past, the panel clearly recommends to establish again a Centre of Excellence program that keeps the proven elements, reflects the lessons learned and incorporates new elements to make the program even more compelling. The ultimate goal of this new CoE Program should be to further strengthen the Swedish HEI and the science system as a whole in a world of increased competitiveness. If Sweden wants to remain one of the

innovation leaders in Europe and at the global scale, excellence in basic research is an absolute prerequisite.

The panel has extensively discussed which elements of the Linnaeus Program should be maintained in a new CoE Program and which elements should be added.

Our recommendations can be summarized under the following key headings:

- Proven excellence: the CoEs have to be based on proven excellence in fundamental research. The projects must be breakthrough-oriented and bold, possibly in emerging fields not serving the established “silos”. A critical mass of PIs should be involved from the very beginning with interdisciplinarity being emphasized.
- Long Duration: the long-term duration of 10 years is a central cornerstone of the CoE initiative. It must be maintained to give a clear perspective for ground-breaking research with a long breath. Quality monitoring should be present but lean.
- Large Flexibility: the flexible use of the funding is essential. Whether it will be used for recruiting, infrastructure or workshops, salaries or equipment must be at the disposition of the CoE and can change over time.
- Appropriate Funding: the amount of funding should depend on the number of PIs involved in a CoE. About 150 000 Euro per PI per annum seems to be a reasonable number to get new research projects off the ground. If required at all, the co-funding from the HEIs should be clearly defined. In any case a clear commitment of support from the HEI should be a condition.
- Open calls: Excellence in research should be the number 1 criterion for selection. The calls should therefore be thematically open and not restricted to certain topics. In a new CoE initiative rolling calls should be considered, i.e. a call every 2-3 years to keep the momentum of renewal in the HEIs going. Inter-university centres should be allowed also.

In conclusion, the evaluation panel hopes that its findings on the Linnaeus program will help the Swedish science system in its ambition to become even more visible and competitive at the global level. Support of excellence in fundamental research was and will be a good investment in the future of the Swedish Higher Education Institutions. Therefore the evaluation panel clearly recommends to consider Centres of Excellence also in the future as an important funding instrument with a proven impressive success record.

# **Appendix 1-9**

## **Appendix 1**

The international Expert Panel for the Final  
Evaluation of the Linnaeus Grant



Date:  
10 January 2020

Reference number:  
3.2-2018-7004

Administrator:  
Maria Bergström

## The international Expert Panel for the Final Evaluation of the Linnaeus Grant

Position in the panel	Name	Affiliation
Chair 1 (N/T)	Jürgen Mlynek	Humbolt Universität, Berlin, Germany
Chair 2 (M)	Marja Makarow	Biocenter Finland, Helsingfors
Member HS	Karl Ulrich Mayer	Max Planck, Institute for Human Development, Berlin, Germany
Member HS	Friedrich Hesse	University of Tübingen, Germany
Member HS	Jane Falkingham	University of Southampton, UK
Member N	Christine Maggs	University of Bournemouth, UK
Member N	Hannu Koskinen	University of Helsinki, Finland
Member T	Bart de Moor	KU Leuven, Belgium
Member T	Antonio Bicchi	University of Pisa, Italy
Member T	Eleanor E.B. Campbell	University of Edinburgh, UK
Member M	Taina Pihlajaniemi	University of Oulu, Finland
Member M	Richard G M Morris	University of Edinburgh, UK
Member M	Christof von Kalle	National Center for Tumor Diseases (NCT) Heidelberg and German Cancer Research Center, Germany

## **Appendix 2**

Terms of reference for the Expert  
Panel of the Final Evaluation  
of the Linnaeus Grant



Vetenskapsrådet

Datum

2019-08-23

Diarienummer

3.2-2018-983

Handläggare

Maria Bergström

## **Terms of reference for the Expert Panel of the Final Evaluation of the Linnaeus Grant**

### ***Introduction***

This Terms of Reference (ToR) describes the background of the evaluation task and outlines the evaluation questions and framework for the appointed Expert Panel performing the evaluation. The ToR also describes the data-collection activities carried out by the Swedish Research Council (SRC) in order to provide the Expert Panel with data for the evaluation.

### ***Background***

In 2005, the Swedish Research Council and Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, were commissioned by the Government to support the development of Centres of Excellence (CoE), known as Linnaeus centres, at Swedish higher education institutions (HEIs). The Government's research bill "Research for a better future" (Govt. Bill 2004/05:80) announced the grant, and the remit was to strengthen the ability of Swedish HEIs to prioritise and profile Swedish research to be internationally competitive at the forefront by building strong research environments. The Swedish Research Council announced the grant in two separate calls in 2005 and 2007, and awarded funding to 20 CoE for ten years at each call, with a maximum grant of 10 million SEK per year during the programme period.

The Linnaeus grant has been evaluated twice for each call; one evaluation after two years aimed at measuring the organisational set-up of the CoEs and the other after five years as a midterm evaluation, assessing both scientific quality and the organisational capacity for conducting excellent research.

A Final Evaluation of the Linnaeus grant was addressed in the research bill, stating that "it is important that the investment in strong research environments as a whole be evaluated to analyse the impact it had on the development of Swedish research, innovation and its funding". This requirement was also stated in the terms for the grant.

### ***The Linnaeus grant***

The following HEIs (Table 1) was awarded funding from the two Linnaeus calls. Each call had approximately just over 100 applications from more than 20 HEIs. None of the smaller HEIs in Sweden received funding.



*Table 1. The distribution of Linnaeus centres and grants awarded per institution.*

HEI	2005 total (mSEK)	2007 total (mSEK)	Total (mSEK)	%
CTH – Chalmers University of Technology	90	66.5	156.5	5.5
GU – University of Gothenburg	52.5	88	140.5	5.0
KI – Karolinska Institutet	194.4	240.2	434.6	<b>15.4</b>
KTH - Royal Institute of Technology	155	90	245	8.7
LiU - Linköping University	76	113	189	6.7
LU – Lund University	530	391	921	<b>32.6</b>
SLU – Swedish University of Agricultural Sciences	50	0	50	1.8
SU – Stockholm University	145.1	145.5	290.6	<b>10.3</b>
UmU - Umeå University	80	90	170	6.0
UU – Uppsala University	68	164.1	232.1	8.2
TOTAL	1441	1388.3	2829.4	100

Four international expert panels evaluated the applications within the following subject areas:  
HSE – Humanities and social sciences (10 applications granted)  
M – Medical sciences (10 applications granted)  
N – Natural sciences (12 applications granted)  
T – Engineering sciences (8 applications granted)

There was no clear instruction in the calls on how the CoE should be organised, or in which scientific field the centres should be in. The Linnaeus centres have organised their research in different ways, which was evaluated in the first evaluation for each call after two years of funding.

### ***Purpose and evaluation questions***

The main purpose of the Final Evaluation of the Linnaeus grant is to provide feedback and learning to the Government, the research funding bodies and the HEIs regarding the experience and effects of the Linnaeus grant.

The key questions for the evaluation are:

1. Has the Linnaeus grant led to the establishment of sustainable research environments, i.e. CoEs, with internationally competitive research?
2. Have the HEIs, through the Linnaeus grant and its terms of conditions, strengthened their ability to prioritise and profile in order to increase their international competitiveness?
3. Has the establishment of Linnaeus centres and their research efforts led to research that has societal relevance?
4. Has the establishment of the Linnaeus centres helped to strengthen the research system's ability to achieve the Government's goal of promoting Sweden as a research nation internationally?



The evaluation questions thus cover three levels of assessment, interlinking in determining the outcomes and impact of the programme. The third question concerns the societal relevance of the Linnaeus grant. This was not addressed in the terms for the grant, but is however important to assess in relation to the current aims of the Swedish Government's research policy<sup>1</sup>, and the merits of the CoE grant for future initiatives.

The outcomes addressed in the four key questions concern internationally competitive research and its visibility, capacity-building for internationally competitive research environments at Swedish HEIs, and finally the societal relevance of the ten-year programme. These evaluation questions has been further developed into an evaluation framework.

## **Evaluation framework**

An evaluation framework has been developed to support the data collection and to frame the evaluation questions regarding scope and depth. The framework consists of three components that are analysed at three organisational levels. The components are:

- *International visibility and competitiveness*: To what extent the established CoEs performed research at the highest international level, and developed processes for research production aiming at the highest international quality, that characterises a CoE environment.
- *Capacity building*: The structures and processes of establishing a CoE organisation, and the collaboration between the CoE and the host HEI.
- *Societal relevance*: To what extent the CoE engaged with the non-academic community in addressing research questions with societal relevance.

The three levels of analysis for the components are:

1. Micro: The Linnaeus centre level at the HEI
2. Meso: The HEI, in terms of the management and financial responsibility for the CoE investments
3. Macro: The Swedish research system, which includes the government and the research funding bodies, and an aggregate level of the HEI in Sweden

The *micro level* of analysis concerns The Linnaeus centre level at the HEIs. The Linnaeus centres have been evaluated separately in two previous evaluations, and will only be assessed independently as CoE's in terms of their scientific output in this evaluation, in order to establish if they have performed research at the highest international level as a CoE. The main part of the micro level of analysis will be at an aggregated level for each HEI, assessing the capacity-building of strong research environments at the HEI with the ability to perform research at world class level, and also as to what extent the Linnaeus grant has led or will lead to, research with high societal relevance.

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<sup>1</sup> Research bill, "Collaboration for knowledge" (Govt. Bill: 2016/17:50), "*Sweden will be one of the world's leading research and innovation countries and a leading knowledge nation, where high-quality research, higher education and innovation lead to society's development and well-being, business competitiveness and respond to the social challenges we face, both in Sweden and globally.*"



The main level of analysis for this evaluation is at the meso level. At this level, we are interested at finding out to what extent the HEIs have used their investments in CoE's to raise their international profile and to prioritise research that supports their CoE investments. We also want to assess the capacity-building at HEI level in regards to for example strategic financial undertakings and recruitment policies that enable international researchers to be employed with specific conditions.

The *macro* level of analysis refers to the aim of the research bill that this research investment relates to. The analysis involves assessment of the Linnaeus grant in terms of to what extent it has strengthened the Swedish position, with internationally competitive research and, to some extent, world-leading research in areas of competitive advantage. This level of analysis will build on the evidence provided by the previous two levels of analysis, and will be aimed at concluding this evaluation in regards of its impact on the research and the research system in Sweden, and to give recommendations for future investments of this kind.

In Table 2, the components and the three levels are presented in the evaluation framework:

*Table 2. Evaluation framework*

	<b>International visibility and competitiveness</b>	<b>Capacity building</b>	<b>Societal relevance</b>
<b>Linnaeus centre (micro)</b>	Review of scientific production and scientific endeavour of the centre	Organisation and leadership Personnel and resource development Collaborations for capacity building Gender balance	Utilisation of research Collaboration with partners outside academia
<b>HEI (meso)</b>	Profiling and prioritisation	Personnel development Financial strategy Communication Collaborations Equal opportunities	Establishment of new educational programs Collaboration with partners outside academia
<b>Sweden/ Research system (macro)</b>	The Linnaeus Grant programme's contribution to Sweden's international attractiveness	Effectiveness of the Linnaeus grant programme in establishing internationally recognised research environments	The Linnaeus grant programme's role in promoting increased societal relevance in research



## Data collection

The following data collection activities are performed by the SRC evaluation team and will be reported to the Expert Panel for the evaluation:

Table 4. Data collection activities

Method	Purpose and use	Framework
Bibliometric analysis of scientific publications	Assessment of scientific quality (output and outcomes)	International visibility and competitiveness/ Linnaeus centre
Peer review of top publications		
Case study/narrative of processes underpinning excellent research activities		
Interviews with HEI management responsible for CoE investments at the HEI, on personnel development, recruitment policies, investments in research infrastructures, etc. at HEI	Assessing to what extent the Linnaeus grant has led to increased international collaboration and recognition, strategy for research and profiling due to investments in CoE. Assessing the support for establishing CoE's at the HEI	International visibility and competitiveness+ capacity building /HEI level  Capacity building/HEI level
Focus groups with the Linnaeus centres at each HEI	Assessing the efforts that the centre has made in establishing an internationally competitive research environment.	Capacity building/HEI level
Case study by Linnaeus centres on societal relevance of research	Assessing to what extent the research has led to important utilisation of research.	Societal relevance/Linnaeus centre level
Questionnaire to researchers	To what extent the researchers themselves assess the importance of the centre for enabling world class research	Capacity building/Linnaeus centre level
Questionnaire to external advisors	To what extent the advisory board has been involved in supporting the centre in reaching its potential as a world class research environment.	Capacity building/ Linnaeus centre level



## ***The evaluation assignment***

The overall evaluation will be conducted by an independent international scientific Expert Panel performing a peer review.

The Expert Panel will consist of fourteen panel members. The Expert Panel will have a first and second chair and in addition twelve members with a generalist competence in research within the following research areas:

- Natural sciences
- Technological sciences
- Humanities and social sciences
- Medical sciences

The Expert Panel will be evaluating the Linnaeus centres and their host HEI's performance in relation to the four key evaluation questions and with regards to the criteria's presented in the evaluation framework.

The evaluation will be carried out in two steps by the Expert Panel. The first step consists of performing a pre-evaluation, and the second step of a hearing with personnel from the HEIs involved and the Linnaeus centres. The hearings are scheduled to 26-31 January 2020.

The Expert Panel will be divided in to two groups for the hearings, where the two chairs will be in charge for each group. When the Expert Panel are having joint meetings, the first chair will be leading the meetings. The two chairs are expected to cooperate and jointly work on the evaluation report together with the rest of the Expert Panel. However, it is the responsibility of the first chair to lead the work and to submit the final draft of the evaluation to the SRC. The report should be submitted **by the 21 February 2020**.

All members of the Expert Panel are responsible for performing a pre-evaluation according to specific guidelines from the SRC which will be send out separately. They are also responsible for assessing the scientific quality of the Linnaeus centres (within their area of research) based on partly bibliometric data and partly on assessment of publications by appointed experts. Furthermore, the Expert Panel is responsible for carrying out hearings with the HEI's and representatives from the Linnaeus centres during the hearing week. Finally, the Expert Panel is responsible for writing an evaluation report to the SRC with recommendations.



## ***Time table for the evaluation***

Below is a table with the main deliverables for the evaluation.

*Table 5.*

<b>Activity</b>	<b>Date</b>	<b>Responsibility</b>
Data collection regarding the Linnaeus centres 2006-2016	Jan-April 2019	SRC
Data collection regarding the Linnaeus centres 2008-2018	Aug-Sept 2019	SRC
Bibliometric analysis and assessment of articles from publication lists	Feb-Sep 2019	SRC
Background report and instructions for pre-evaluation to the panel	Nov 2019	SRC
Pre evaluation of the Linnaeus grant	Dec 2019	Panel
Hearing with HEIs and Linnaeus centres in Stockholm	Jan 2020	Panel
Expert Panel evaluation report, deadline	Feb 2020	Panel
Final report, deadline	Feb 2020	SRC



## **Appendix 3**

Guidelines for the pre-evaluation of the Final Evaluation of the Linnaeus grant.

2019-11-07

## Guidelines for the *pre-evaluation* of the Final Evaluation of the Linnaeus grant.

### INTRODUCTION

This document contains the information necessary for conducting the pre-evaluation of the Final Evaluation of the Linnaeus grant. The document should be read alongside the Terms of Reference for the evaluation (revised version).

The Experts Panels overall assignment in this evaluation is to assess the impact of the Linnaeus program and to what extent the provided evidence can be attributed to this ten year investment. The evaluation will be carried out in two steps by the Expert Panel. The first step consists of performing a pre-evaluation, and the second step of hearings with personnel from the involved HEIs and their Linnaeus centres.

The pre-evaluation of the Linnaeus grant is an important preparation for the hearings that will facilitate the rest of the evaluation process.

The final evaluation focuses on the impact of this centre of excellence (CoE) investment/program in Sweden after the ten year grant period. The purpose of the investment was to strengthen Sweden's reputation as an internationally competitive research nation with strong research environments and internationally recognised Higher Education Institutions (HEI).

The 40 Linnaeus centres that was awarded funding, each received between 5-10 million SEK annually for ten years. In order to participate in the two calls (2005 and 2007), the HEI needed to endorse the application from the centre. The selection process was performed with a peer review of more than 100 applications in each call and the process was rigorous in order to select centres that had the ability to become among the internationally leading research environments in their field of research. The hosting HEI's needed to co-fund the Linnaeus centre by an additional 50 percent of the grant sum. The centres have been evaluated twice, the first evaluation after two years focusing on the organizational set-up of the centre, and the second evaluation after five years focusing more on the scientific quality of the centres research and research production.

Below are the 40 awarded Linnaeus centres area of research.

Table 1. The area of research of the Linnaeus centres

Abbreviation	Area	Granted applications
HS	Humanities and social sciences	10 applications granted, one centre was terminated after the second evaluation
M	Medical sciences	10 applications granted
N	Natural sciences	12 applications granted
E	Engineering sciences	8 applications granted

2019-11-07

## THE PRE EVALUATION ASSIGNMENTS

The pre-evaluation is organized around answering three of the four evaluation questions:

1. Has the Linnaeus grant led to the establishment of sustainable research environments, i.e. CoEs, with internationally competitive research?
2. Have the HEIs, through the Linnaeus grant and its terms of conditions, strengthened their ability to prioritise and profile their research for increasing their international competitiveness?
3. Has the establishment of Linnaeus centres and their research efforts led to research that has societal relevance?

The first pre-evaluation question is divided into two tasks. The first task is to assess the scientific quality of each Linnaeus centre, and the second to assess the capacity building at the Linnaeus centres jointly for each HEI. The second evaluation question concerns the HEI and their capacity building for international visibility and attractiveness. The third and final evaluation questions is to assess the societal relevance of the research performed and the Linnaeus centres collaboration with the society outside academia, for each Linnaeus centre.

For pre-evaluation assignment 1a and 3, the Expert Panel is asked to evaluate each Linnaeus centre regarding their scientific quality and societal relevance. However, for this task the Expert Panel is divided into four groups, one for each subject area, according to table 1. The Expert Panel members only needs to assess those Linnaeus centres that match their own area of research. For the other pre-evaluation assignments the Expert Panel members should assess all ten HEI's.

Each pre-evaluation assignment should be performed independently, i.e. not be assessed in relation to each other. The data compilation provides the evidence for the assessments and is specific for each assignment. Furthermore, each assignment also have specific evaluation criteria's and grading scales that match the subject of the evaluation question. It is also important to write an explanatory comment next to the grading, which enables a cross comparison between the Expert Panel members assessment as to what extent the panel members differs on how the evaluation criteria's and the grading's are interpreted and used. This enables us to identify if there is a need for calibration of the panel members assessments, when we meet in January prior to the hearings.

### INSTRUCTION:

1. Use the data provided in e-mail and/or in the Boxfile which was attached/linked in the email with these guidelines.
2. Fill in the template provided for the pre-evaluation assignment with your grading and comments.
3. When you write the comments for clarifying and motivating your grading, please, refer to the evaluation criteria's regarding the performance of the Linnaeus centre/ HEI.
4. Save the template and give it your name before sending it back to us.
5. Send your pre-evaluation to [linnefinal@vr.se](mailto:linnefinal@vr.se) no later than **2020-01-12**

2019-11-07

## 1. SCIENTIFIC QUALITY AND CAPACITY BUILDING

The first task within this assignment is to give an overall grade to the Linnaeus centres within your area of research, regarding the scientific performance and if the centre managed to sustain the performance level throughout the program.

### *Assignment 1a:*

This first assignment concerns the scientific quality performed at the Linnaeus centre. We have divided this task with regards to the Expert Panel member's area of research. You will be assessing the Linnaeus centres depending on the area of research you represent (se table 1.)

In order to assess the scientific performance of the Linnaeus centres (1a), it is important to establish to what extent the research performed was internationally recognized, was part of a collaborative effort and showed evidence of research break through or high risk-high gain qualities.

<p><b>Evaluation question:</b> Has the Linnaeus grant led to the establishment of sustainable research environments, i.e. CoEs, with internationally competitive research?</p>
<p><b>Evaluation component:</b> Scientific quality</p>
<p><b>Level of analysis:</b> Linnaeus centre (Micro)</p>
<p><b>Evaluation criteria – assess to what extent the provided data show evidence of the following for the respective Linnaeus centre:</b></p> <ol style="list-style-type: none"> <li>1. High scientific quality of the research at the centre</li> <li>2. Breakthrough/High risk-high gain research present at centre</li> <li>3. Interdisciplinary research endeavours present at centre</li> <li>4. National and international research collaboration</li> <li>5. International recognition – overall assessment of the centres position in the international research community</li> </ol>
<p><b>Data compilation – the provided data for the pre-evaluation task:</b> Bibliometric analysis – volume of publications, citation analysis, network maps Peer review of publications by external experts – assessed according to the REF scale Case study (scientific) provided by the Linnaeus centre Background information of Linnaeus centre from previous evaluations</p>
<p><b>Grading scale:</b> One overall grade for each CoE's scientific performance and international recognition with comments:</p> <ol style="list-style-type: none"> <li>A. World leading or equivalent</li> <li>B. Internationally recognition/competitive</li> <li>C. Nationally recognition/competitive</li> <li>D. Unclassified – quality that falls below the standard of national recognised research</li> </ol>

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### *Assignment 1b:*

The second task is to give an overall assessment of the capacity building regarding establishing internationally competitive Linnaeus centres<sup>1</sup> at the HEI, for each HEI.

The conditions for using the funding within the Linnaeus program was clear and with little administrative requirements – to perform research of the highest quality and make the necessary changes in support of this effort. However, in order to establish sustainable CoE's, the capacity building of a CoE is essential so that the research environment is able to draw from the collective knowledge present at the centre, but also to sustain the research capacity even if key personnel are leaving the centre operations. The capacity building within a CoE is a joint responsibility between the CoE and the hosting HEI. The Linnaeus centres should thus be assessed regarding the capacity building for establishing strong sustainable centres of excellence with the support from the hosting HEI.

<p><b>Evaluation question:</b> Has the Linnaeus grant led to the establishment of sustainable research environments, i.e. CoEs, with internationally competitive research?</p>
<p><b>Evaluation component:</b> Capacity building for establishing a CoE</p>
<p><b>Level of analysis:</b> Linnaeus centres aggregated for each HEI (Micro)</p>
<p><b>Evaluation criteria – assess to what extent the provided data show evidence of the following for the respective HEI:</b> <b>Evidence of capacity building present at the Linnaeus centres:</b></p> <ol style="list-style-type: none"> <li>1. Centre identity and organisation</li> <li>2. Management and leadership</li> <li>3. Knowledge transfer within centre</li> <li>4. Collaboration and communication</li> <li>5. Added value</li> </ol>
<p><b>Data compilation – the provided data for the pre-evaluation task:</b> Focus group data compiled for each HEI (Interview report) Data on financing and personnel for each centre (Financing and personnel report) Survey of researchers (Survey report) Organisation map</p>
<p><b>Grading scale:</b> Evidence showing:</p> <ol style="list-style-type: none"> <li>A. Overall excellent CoE environments at the HEI</li> <li>B. Overall strong CoE environments at the HEI</li> <li>C. Overall satisfactory CoE environments at the HEI</li> <li>D. Unclear or weak CoE environments at the HEI</li> </ol>

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<sup>1</sup> Some of the Linnaeus centres that was awarded funding was already established as centres prior to the grant. But most of the centres were established when they received the grant.

2019-11-07

## 1. CAPACITY BUILDING FOR INCREASING INTERNATIONAL COMPETITIVENESS AT THE HEI

The assignment concerns assessing the capacity building at the hosting HEI regarding to what extent the investment in CoE led to profiling and priorities of the research portfolio at the HEI in order to strengthen the international attractiveness and competitiveness. The government specifically addressed the HEI's in the research bill (2004/05:80) when announcing this investment with the expectation that the awarded HEI's should use the CoE program in strengthening their international profile and competitiveness.

<p><b>Evaluation question:</b> Have the HEIs, through the Linnaeus grant and its terms of conditions, strengthened their ability to prioritise and profile their research in order to increase their international competitiveness?</p>
<p><b>Evaluation component:</b> Scientific quality and capacity building at HEI</p>
<p><b>Level of analysis:</b> HEI (Meso)</p>
<p><b>Evaluation criteria – assess to what extent the provided data show evidence of the following for the respective HEI:</b> Scientific quality (aggregated for Linnaeus centres at the HEI) of Linnaeus centres at the HEI in relation to the overall research production at the HEI <b>Capacity building at the HEI:</b></p> <ol style="list-style-type: none"> <li>1. General knowledge and understanding of the concept of CoE for enhancing research quality and building strong research environments with critical mass at HEI</li> <li>2. Management of CoE investment for increasing the attractiveness of the HEI</li> <li>3. Profiling of research portfolio at HEI</li> <li>4. International visibility of HEI</li> </ol>
<p><b>Data compilation – the provided data for the pre-evaluation task:</b> Bibliometric analysis for each HEI (Bibliometric report) Interview data compiled for each HEI (Interview report) Survey of researchers and of external advisors (Survey report)</p>
<p><b>Grading scale:</b> Evidence showing:</p> <ol style="list-style-type: none"> <li>A. Excellent use of CoE investment for increasing the international competitiveness at the HEI</li> <li>B. Good use of CoE investment for increasing the international competitiveness at the HEI</li> <li>C. Some use of CoE investment for increasing the international competitiveness at the HEI</li> <li>D. Weak or no evidence of use of CoE investment for increasing the international competitiveness at the HEI</li> </ol>

2019-11-07

### 3. SOCIETAL RELEVANCE OF THE LINNAEUS CENTRES

The task is to assess if the Linnaeus centres and their research efforts have led to societal relevance. The Linnaeus centres have submitted one case study per centre for this task. The panel members will be assessing the societal impact case studies of the Linnaeus centres relevant to their own research area.

Societal relevance was not initially part of the expected outcomes of the Linnaeus program, but the question of assessing the societal relevance or impact of research has become more and more important in Sweden over the years, and are now part of the aim for the government's research policy. The reason for including societal relevance as one of the evaluation questions is therefore to increase the relevance of the evaluation for policy makers today. We have asked each of the Linnaeus centres to provide one case study of societal impact. We have since, after the instructions of the case studies where sent out to the Linnaeus centres, decided to use the broader concept of societal relevance rather than impact. We have used the very broad definition provided in the REF framework<sup>2</sup>.

<b>Evaluation question:</b> Has the establishment of Linnaeus centres and their research efforts led to research that has societal relevance?
<b>Evaluation component:</b> Societal relevance
<b>Level of analysis:</b> Linnaeus centre (Micro)
<b>Evaluation criteria – assess to what extent the provided data show evidence of the following for the respective Linnaeus centre:</b> Reach and significance (see attached definitions and guidance in APP. 1)
<b>Data compilation – the provided data for the pre-evaluation task:</b> Case study (societal)
<b>Grading scale:</b> Evidence showing: A. Research with exceptional societal relevance B. Research with high societal relevance C. Research with some societal relevance D. Weak or no evidence of societal relevance

<sup>2</sup> For the purposes of the REF, impact is defined as an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. Impact includes, but is not limited to, an effect on, change or benefit to; the activity, attitude, awareness, behaviour, capacity, opportunity, performance, policy, practice, process or understanding; of an audience, beneficiary, community, constituency, organisation or individuals; in any geographic location whether locally, regionally, nationally or internationally. (Part 3, section 3 in Guidance on submissions)

2019-11-07

## APPENDIX 1

### *Case study for societal relevance/impact*

The instructions for writing the case study to the Linnaeus centres included the following description on what was to be included:

The case study should describe impact outside academia that have provided benefits to one or more areas of the economy, society, public policy and services, health, production, environment, or quality of life; whether locally, regionally, nationally or internationally. Impact can be manifested in a wide variety of ways including, but not limited to; the many types of beneficiary (individuals, organizations, communities, regions and other entities); impact on products, processes, behaviours, policies, practices; and avoidance of harm or the waste of resources.

It is important that the case description clearly states who or what has benefitted, been influenced or acted upon and the role that the Linnaeus centre played to make the impact possible.

When assessing the societal relevance of the case studies the panel should use the criteria developed by the REF, which are significance and reach. According to REF, the definition of reach and significance are:

**Reach** will be understood as the extent and/or diversity of the beneficiaries of the impact, as relevant to the nature of the impact. Reach will be assessed in terms of the extent to which the potential constituencies, number or groups of beneficiaries have been reached; it will not be assessed in purely geographic terms, nor in terms of absolute numbers of beneficiaries. The criteria will be applied wherever the impact occurred, regardless of geography or location, and whether in the UK or abroad.

**Significance** will be understood as the degree to which the impact has enabled, enriched, influenced, informed or changed the performance, policies, practices, products, services, understanding, awareness or wellbeing of the beneficiaries. (Panel criteria and working methods, page 64)

## **Appendix 4**

Instructions for reporting publications  
to the final evaluation of the Linneaus  
grants



Vetenskapsrådet

Datum

2018-05-25

Diarienummer

3.2-2018-983

Handläggare

Maria Bergström

To the Linneaus environments receiving  
Linneaus grants

## Instructions for reporting publications to the final evaluation of the Linneaus grants

This is the instruction for collecting and assembling a publication list for the full program period of the Linneaus grant for each Linneaus environment. Every publication that is included in the list should meet all of the criteria specified below:

- Select publications related to the research that has been the core of the center and that originates from the application to VR for the Linneaus grants. All publications published during 2006-2016 for the call 2005 and 2008-2018 for the call 2007 should be included.
- List only publications by authors that have been appointed by, or affiliated to, the Linneaus center during the program period.
- Publications should be indicated in the following way:
  - Author (only the authors appointed by or affiliated to the center should be listed)
  - Title of publication
  - Year of publication
  - Publication type: Indicate the number of publication type according to the following list
    1. Article
    2. Review
    3. Conference papers
    4. Monography
    5. Other
  - DOI (Digital Object Identifier) of publication

Attached to this instruction is an excel template for the publication list. When reporting the list, name the list with the name of the Linneaus center.

Send the list to [linne2019@vr.se](mailto:linne2019@vr.se) no later than 20 February 2019.



## **Appendix 5**

Instruction for the  
selection of top publications



Vetenskapsrådet

Date  
2018-12-14  
Administrator  
Karin Tegerstedt

Reference number  
3.2-2018-983

## Instruction for the selection of top publications

As part of the final evaluation of the Linnaeus grant, experts will assess the total body of publications from each Linnaeus centre. You have previously been asked to compile a list of publications from your Linnaeus centre according to the instructions below:

- Select publications related to the research that has been the core of the centre and that originates from the application to VR for the Linnaeus grants. All publications published during 2006-2016 for the call 2005 and 2008-2018 for the call 2007 should be included.
- List only publications by authors that have been appointed by, or affiliated to, the Linnaeus centre during the program period.

We would like to make a clarification regarding the “Authors” column in the publication list, we ask you to list only the authors from the centre, **or**, if all authors are listed, please highlight authors from the centre in bold.

### **Peer review of top publications**

Experts appointed by the Swedish Research Council will review the top publications from the centre. We therefore ask you to select, among the listed publications, eight that you consider your top publications. The experts will assess the scientific quality of the submitted top publications in terms of *originality*, *significance* and *rigour*.

The experts will also assess the scientific scope of the centre, and the development of the centre during the grant period. This will mainly be evaluated based on the publication list, but also on the quality of the top publications. We therefore encourage you to select publications that represent several different researchers/groups at your Linnaeus centre, and to select publications from a large part of the grant period.

The selected top publications should be relevant to the profile of the centre. We ask you to specify how the Linnaeus grant contributed to the selected top publications. Name the provided word template with the abbreviation of the Linnaeus centre

The eight top publications shall be submitted in PDF format in a BOX folder provided by the Swedish research council and named with abbreviation of the Linnaeus centre. One PDF file per publication and named according to the abbreviation of the centre and serial number (for example *LC\_1.pdf*, *LC\_2.pdf* ...etc.). The selected top publications shall also be highlighted in yellow in the excel list. Name the list with the abbreviation of the Linnaeus centre.

Please submit your publications in the BOX folder, and send the word file and the excel list to [linne2019@vr.se](mailto:linne2019@vr.se), no later than **February 20, 2019**.



*For questions concerning the peer review, please contact:*

Karin Tegerstedt, senior analyst

[karin.tegerstedt@vr.se](mailto:karin.tegerstedt@vr.se), tel: +46 8 546 44 257

*For questions concerning the evaluation of Linnaeus grants, please contact:*

Maria Bergström, project leader

[maria.bergstrom@vr.se](mailto:maria.bergstrom@vr.se), tel: +46 8 546 44 226



## **Appendix 6**

Scientific impact case study



Vetenskapsrådet

Date  
2019-05-21  
Administrator  
Karin Tegerstedt

Reference number  
3.2-2018-983

## SCIENTIFIC IMPACT CASE STUDY

In the evaluation of the Linnaeus grant it is important to know what added value the Linnaeus grant, and the formation of Linnaeus centres, have accomplished in terms of scientific performances.

Therefore, we ask you to describe one case where research performed at your Linnaeus centre has made a significant scientific impact. We want you to describe a case where you have been particularly successful (e.g. an impact publication). The case should include the way you have worked to achieve the specific major scientific impact. The underpinning publications and the scientific impact of the research should have occurred during the Linnaeus program period for your Linnaeus Centre.

The panel will assess the scientific impact of the case in terms of the criteria *reach*, *significance* and *attribution*.

The case should be written in the template below, and include the following information:

- **Scientific impact:** describe one case of a major scientific impact in your research area.
- **Underpinning research:** a brief description of the key content of the research underpinning the case.
- **Key factors:** a description of key processes and factors that you consider contributed to the achievement. Here it is important to describe how the centre and the work there within have contributed. Describe what your collaboration processes and strategies to reach out with your research have looked like and how they have contributed. You may also describe how other contributing factors outside your organization that you deem to have been of importance.
- **References:** publications or the equivalent that gives evidence for the case.

**Please fill in the template below and send to [linne2019@vr.se](mailto:linne2019@vr.se) no later than 10 September, 2019. Name the template with the abbreviation of the Linnaeus centre.**

*For questions concerning the scientific impact case study, please contact:*

Karin Tegerstedt, senior analyst  
[karin.tegerstedt@vr.se](mailto:karin.tegerstedt@vr.se), tel: +46 8 546 44 257

*For questions concerning the evaluation of Linnaeus grants, please contact:*

Maria Bergström, project leader  
[maria.bergstrom@vr.se](mailto:maria.bergstrom@vr.se), tel: +46 8 546 44 226



# SCIENTIFIC IMPACT CASE

*Name of Linnaeus Centre*

*Title of the case*

*Summary (max 100 words)*

*Scientific impact case study (max 3 pages)*



## **Appendix 7**

Case study of societal impact



Vetenskapsrådet

Date  
2019-05-21

Reference number  
3.2-2018-983

Administrator  
Magnus Lagerholm

## CASE STUDY OF SOCIETAL IMPACT

In the evaluation of the Linnaeus grant it is important to know what added value the Linnaeus grant, and the formation of Linnaeus centres, have accomplished in terms of societal impact.

We therefore ask you to fill in in the below societal impact template. You should describe a case where research performed at your Linnaeus Centre has contributed to beneficial impact in some part of society. The impact of the research should have occurred during the Linnaeus program period for your Linnaeus Centre.

The case study should describe impact outside academia that have provided benefits to one or more areas of the economy, society, public policy and services, health, production, environment, or quality of life; whether locally, regionally, nationally or internationally. Impact can be manifested in a wide variety of ways including, but not limited to; the many types of beneficiary (individuals, organizations, communities, regions and other entities); impact on products, processes, behaviours, policies, practices; and avoidance of harm or the waste of resources.

It is important that the case description clearly states who or what has benefitted, been influenced or acted upon and the role that the Linnaeus centre played to make the impact possible.

The case should include the following information:

- **Societal impact:** a case of impact beyond academia.
- **Underpinning research:** the key content of the research underpinning the case, and an explanation of why this content was essential to the impact.
- **Key factors:** the key factors you consider contributed substantially to the impact, including your own collaboration processes and strategies to reach out with your research as well as contributing factors outside your organization that you deem to have been of importance for the impact of the research.
- **References** to publications from your Linnaeus Centre that evidence the essential contribution this research has made to the impact case.

**Please fill in the template below and send to [linne2019@vr.se](mailto:linne2019@vr.se) no later than 10 September, 2019. Name the template with the abbreviation of the Linnaeus centre.**

*For questions concerning the societal impact case study, please contact:*

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[magnus.lagerholm@vr.se](mailto:magnus.lagerholm@vr.se), tel: +46 8 546 44 058

*For questions concerning the evaluation of Linnaeus grants, please contact:*

Maria Bergström, project leader  
[maria.bergstrom@vr.se](mailto:maria.bergstrom@vr.se), tel: +46 8 546 44 226



# Societal Impact Case Study

*Name of Linnaeus Centre*

*Title of case study*

*Summary of the impact (max 100 words)*

*Societal impact case study (max 3 pages)*



## **Appendix 8-9**

8: Interview instructions and questions

9: Survey questionnaire to researchers  
and external advisors

## Appendix 8: Interview instructions and questions

### Introduction to the Linnaeus evaluation interviews

The interviews within the final evaluation of the Linnaeus program has been carried out in two rounds. The first round was done with the HEIs and Linnaeus centres funded in the 2006 call and the second round with the ones who got funded in the 2008 call. In total we have done approximately 60 interviews.

These interviews replace the self-evaluation forms that otherwise would have been collected as a background material.

The interviews has been carried out on three levels and separately for calls:

- Level 1 management: Deputy Vice Chancellor (vice chancellor/pro-rector), or the equivalent, responsible for the university's CoE policy/strategy/ investments. About 1 hour interviews.
- Level 2 management: Senior director/advisor responsible for the research strategy/agenda and priorities at the University. About 1 hour interviews.
- Level 3 centres: Focus group interviews with the scientific and administrative leadership at a joint session with the Linnaeus Centres. Maximum of 2 people/centre for 2 hours. These interviews involved 1-3 centres per session.

The interviews were recorded and automatically transcribed. The transcriptions has then been condensed and shortened to make the material useful.

The four interviews with level 1 and 2 has been combined into one text for each HEI. Some alterations were done of the questions between the interview rounds, due to the need of more in-depth information from the respondents on certain topics.

The focus group interviews, level 3, has been combined into two texts for each HEI, one per call. The interview guide has been used between the two interview rounds, apart from some questions on research schools that only were relevant for the 2006 call.

Even though all interviews has been conducted using interview guides the coverage varies between questions. You will also find the acronym "NoQ" and "No Answer", meaning the question has already been answered or the answer were not adding any relevant information.

The questions are categorised based on their topics. For the interviews with management level these categories are:

- General questions on CoE (Centre of Excellence)
- Management of CoE investment at HEI
- Support to the CoE
- Profiling

And for the interviews with the centres they are:

- Organisation
- Leadership and knowledge transfer
- Collaboration
- Communication
- Present

In several interviews strategic research areas (SRA) are mentioned. SRA was an investment in strategic research areas launched in the 2008 Government Bill 'A Boost to Research and Innovation' (prop. 2008/09:50) and was carried out by the Swedish Research Council, Formas, Vinnova and the Swedish Energy Agency on behalf of the government. The initiative included 20 strategic research areas (SRAs) with 43 research environments at 11 host universities and were funded with 5270 MSEK during 2010-2014.

## Guide for interviews with the general management at the HEI's

### General questions on CoE

1. In your opinion, what constitutes a Centre of Excellence?
2. Why is Centre of Excellence investments important to the university?
3. What incentives and activities did the Linnaeus program create for the university?
4. Did you have procedures for quality assurance and selection criteria's of applications, and support during the program period?
5. Was the Linnaeus program a successful measure for establishing Centre of Excellence at your university?
6. Has the Linnaeus centres only been established around the application for the Linnaeus grant? Or have the HEI worked to establish a sustainable CoE beyond the Linnaeus grant?
7. What is necessary for creating research environments with critical mass?

### Management of CoE investment at HEI

8. How have you interacted with the Linnaeus centres during the program period?
9. In what way have the university assured that there has been a good leadership and management culture at the Linnaeus centres?
10. What leadership culture fosters world leading research? Have the Linnaeus centres been characterized by this type of leadership?
11. Has the establishment of strong research environment, such as the Linnaeus centres, led to management challenges for the HEI central level?
12. What have been the challenges of the Linnaeus program in relation to the overall research strategy at you university?
13. What have been the challenges in relation to research agendas at faculty level?

### Support to the CoE

14. How has the internal collaboration and coordination been organised between the faculty level/s and the CoE Management?
15. How have you supported the development of an interdisciplinary research environment at the Linnaeus centres?
16. What has been your financial strategy for co funding the Linnaeus centre/s?
17. Has the faculty supported the establishment of the Linnaeus centre? (in addition to co-funding of the Linnaeus grant)
18. Has the HEI provided the necessary research environment facilities, such as research infrastructures, for the Linnaeus centres for their development during the program period?
19. How have you worked to strategically attract talented researchers to the Linnaeus centres?

### Profiling

20. What does profiling of the universities in Sweden means to you?
21. Does the universities in Sweden need to be more profiled?
22. From a national perspective, where is your area of strength in research? Do you have a strategic research profile for the whole university?
23. To what extent has the HEI increased the international visibility and attractiveness as a research environment during the Linnaeus program period, in general?
24. Has the Linnaeus program been a successful measure for establishing Centre of Excellence?

## Guide for interviews with the Linnaeus centres

### Organisation

1. In your opinion, what constitutes a Centre of Excellence?
2. Has the centre developed joint aims and targets for the program period? Who were involved?
3. How has the differences in gender balance been addressed at the centre?

### Leadership and knowledge transfer

4. What leadership culture fosters world leading research? Has the Linnaeus centre been characterized by this type of leadership?
5. How do you make sure that the centre performs world leading research?
6. How have you worked with knowledge transfer in the Linnaeus centres? (Specific activities)?
7. What is the benefit of having external advisors? How have they supported the centre?
8. PhD education
  - a. PhD-students: How has the PhD students benefitted from being part of the Linnaeus centre?
  - b. PhD-school: How has the PhD school been a part of the establishment of the Linnaeus centre? What role has it played in the scientific development of the centre? (2006 call only)

### Collaboration

9. What is the value of collaboration with partners outside academia for research?
10. In what way have the Linnaeus centres been influenced by societal challenges regarding the research at the centres?

### Communication

11. How do you work with the visibility of the centre so that it/they become internationally known?

### Present

12. What added value came out of the ten year Linnaeus program?
13. What is the status of the Linnaeus centres at your university at the moment?

## Appendix 9: Survey questionnaire to researchers and external advisors

### Survey to reserachers

The Swedish Research Council is currently performing a final evaluation of the Linnaeus grant. The Linnaeus grant was directed at developing centres of excellence (CoE) with internationally competitive research. For more information on the Linnaeus Grant and the evaluation, see [Final evaluation of the Linnaeus Grant](#).

You have received this questionnaire since you have been listed as a researcher that have performed research at a Linnaeus Centre named during the grant period. The questions are foremost directed at assessing the capacity building for enabling world leading research at the centre and what you as a researcher gained by performing research in this environment.

The first questions concerns background information about you as a researcher. The following sections in the questionnaire are divided into three themes. The first theme concerns the role you had in the Linnaeus centre, the second theme concerns your view of the Linnaeus centre as a centre of excellence, and the final theme concerns your own benefit of being part of a centre of excellence.

The information will be analysed as aggregate data and will not be able to trace back to you as a respondent. The response is therefore anonymous. You can read further about how the Swedish Research Council handles survey data below.

We are very grateful for you response!

The Linnaeus Evaluation team

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Read about how the Swedish Research Council handles your personal data

---

1.  
Have you been involved in a Linnaeus Centre?

(This refers to if you have been performing research, your PhD education, or otherwise worked at the Linnaeus centre.)

- Yes  
 No

2. Do you want to participate in the survey?

- Yes  
 No
- 

3. Do you have a doctoral degree (PhD)?

- Yes  
 No
- 

4.  
What is your current employment?

(Tick the category below that best match your main current position/employment at your current institution/workplace)

- PhD student
- Postdoctoral researcher
- Assistant Professor
- Professor
- Lecturer
- Visiting Professor
- Other research and teaching staff
- Administrative staff
- Technical staff
- If other, please specify

---

**5a. Specify your current main academic affiliation. If other than a Swedish Higher Education Institution (HEI) or other organisation not in the list, please specify below**

If other than a Swedish Higher Education Institution (HEI), a non academic affiliation or not in the list, please specify:

**5b How much funding have you had access to annually on average?**

(Indicate how much research funding you have access to annually during your time at the Linnaeus Centre and your current research funding situation - on average)

	Average annual research budget at the Linnaeus Centre	Average annual research budget currently
No research budget	<input type="radio"/>	<input type="radio"/>
< 499 999	<input type="radio"/>	<input type="radio"/>
500 000 - 999 999	<input type="radio"/>	<input type="radio"/>
1 000 000 – 1 999 999	<input type="radio"/>	<input type="radio"/>
2 000 000 – 2 999 999	<input type="radio"/>	<input type="radio"/>
3 000 000 – 3 999 999	<input type="radio"/>	<input type="radio"/>
4 000 000 – 4 999 999	<input type="radio"/>	<input type="radio"/>
5 000 000 – 5 999 999	<input type="radio"/>	<input type="radio"/>
6 000 000 – 6 999 999	<input type="radio"/>	<input type="radio"/>
7 000 000 – 7 999 999	<input type="radio"/>	<input type="radio"/>
8 000 000 – 8 999 999	<input type="radio"/>	<input type="radio"/>
9 000 000 – 9 999 999	<input type="radio"/>	<input type="radio"/>
10 000 000 <	<input type="radio"/>	<input type="radio"/>
Not applicable	<input type="radio"/>	<input type="radio"/>

---

**6. What is your gender?**

- Female
- Male
- Don't wish to answer

---

Involvement in the Linnaeus Centre

The following questions concerns your involvement at the Linnaeus Centre regarding how you were recruited, degree of involvement and the role/s you hade at the centre.

7. Please, verify at what Linnaeus Centre you have been involved in.

You can only indicate one centre, so please select the centre you consider as your main centre.

---

8. What was your main research subject during your period at the Linnaeus Centre?

---

9. How were you recruited to the Linnaeus Centre?

- I was already employed at the department/institution forming the Linnaeus Centre
- Directly recruited by the Linnaeus Centre
- Nationally recruited by the Higher Education Institution
- Internationally recruited by the Higher Education Institution
- By application to the Linnaeus Centre
- If other, please specify

---

10. Between which years and to what degree where you active in the Linnaeus Centre (percentage of full time employment)?

	1-25 %	26-50 %	51-75 %	76-100%	Not applicable
2008 – 2010	<input type="radio"/>				
2011 – 2013	<input type="radio"/>				
2014 – 2016	<input type="radio"/>				
2017 – 2018	<input type="radio"/>				

Please indicate which position/s or role/s you have had at the Linnaeus Centre.

(Indicate the boxes relevant for all your positions at the Linnaeus centre)

- PhD student
- Postdoctoral researcher
- Assistant Professor
- Professor
- Lecturer
- Visiting Professor
- Other research and teaching staff
- Administrative staff
- Technical staff
- If other, please specify

---

## Assesment of Center of Excellence

In the following theme we would like your opinion on what you consider important at a Centre of Excellence (CoE). We also want you to assess to what extent those aspects have been present at your Linnaeus Centre

The questions will cover three areas concerning:

- Management and leadership
- Collaboration and knowledge transfer
- Societal relevance of the performed research

### Management and leadership - general

The aspects below are known features of CoE's, and we ask you to assess the importance of them for performing research at the highest international level. This question concerns management and leadership and we ask of your general opinion regardless of your actual experience or formal knowledge of CoE's.

In your opinion, how important is it that a Centre of Excellence should ...

	Not important at all	Not so important	Quite important	Very important	Don't know/Not applicable
... have a clear management structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a leadership-culture that fosters world-leading research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a management that invites researchers to participated in the center activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have clear objectives and targets for its scientific endeavour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a management that promotes a gender balance at all levels within the research workforce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a management that addresses gender equality and gender perspectives to ensure that research opportunities are equal for all eligible researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Management and leadership at the Linnaeus Centre

This question concerns the management and leadership at your Linnaeus centre. We ask you to assess to what extent the aspects below was present when you were involved in the centre.

In your opinion, to what extent has the Linnaeus Centre been characterised by the following:

	Not at all	To some extent	To a large extent	To a very large extent	Dont't know/Not applicable
A clear management structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
A leadership culture that fostered a world-leading research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that invited researchers to participate in the center activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear objectives and targets for its scientific endeavour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has promoted a gender balance at all levels within the research workforce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has addressed gender equality and gender perspectives to ensure that research opportunities are equal for all eligible researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Collaboration and knowledge transfer - general

The aspects below are known features of CoE's, and we ask you to assess the importance of them for performing research at the highest international level. This question concerns collaboration and knowledge transfer and we ask of your general opinion regardless of your actual experience or formal knowledge of CoE's.

In your opinion, how important are the following conditions for the collaboration and knowledge transfer in a Center of Excellence:

	Not important at all	Not so important	Quite important	Very important	Don't know/Not applicable
Co-location of researchers at the same premises that enables researchers to meet on a daily basis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Regularly and frequently meetings at joint venues (weekly up to monthly)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that promotes knowledge transfer between researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that encourage mobility and provides research exchange opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that provides opportunities for external researchers to engage in the research at the Centre	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

15.

Collaboration and knowledge transfer at the Linnaeus Centre

This question concerns collaboration and knowledge transfer at your Linnaeus centre. We ask you to assess to what extent the aspects below was present when you were involved in the centre.

In your opinion, to what extent has the Linnaeus Centre been characterised by the following:

	Not at all	To some extent	To a large extent	To a very large extent	Don't know/Not applicable
Co-location of the researchers at the same premises that enabled researchers to meet on a daily basis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Regularly and frequently meetings at joint venues (weekly up to monthly)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has been promoting knowledge transfer between researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that encouraged mobility and research exchange opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has been providing opportunities for external researchers to engage in the research at the Centre	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16.

Societal relevance - general

The aspects below are known features of CoE's, and we ask you to assess the importance of them for performing research at the highest international level. This question concerns societal relevance for a Center of Excellence (CoE) and we ask of your general opinion regardless of your actual experience or formal knowledge of CoE's.

In your opinion, how important is it that within a Centre of Excellence there are ....

	Not important at all	Not so important	Quite important	Very important	Don't know/Not applicable
... collaborations with non-academic partners	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... clear research impact pathways (linking basic and applied research to future utilization of research)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... research-communication targeting non-academics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... career models enabling researchers to move between academia and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17.

Societal relevance at the Linnaeus Centre

This question concerns the societal relevance at your Linnaeus centre. We ask you to assess to what extent the aspects below was present when you were involved in the centre.

In your opinion, to what extent has the Linnaeus Centre been characterised by the following:

	Not at all	To some extent	To a large extent	To a very large extent	Do not know/Not applicable
Collaborations with nonacademic partners	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear ideas on the research impact pathway (linking basic and applied research to future utilization of research)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research-communication targeting non-academics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Career models that enabled researchers to move between academia and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The Linnaeus Centre as research environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

In the following theme we ask you to assess the Linnaeus Centre as a research environment in certain aspects and if this environment has been beneficial for you as researcher. Furthermore we would like you to assess the overall importance of the Linnaeus centre for your research and if the centre had a world class set-up.

---

18. Has the Linnaeus centre been a good research-environment for you as researcher regarding:

	Not at all	To some extent	To a large extent	Completely	Not applicable
Enabling interdisciplinary projects	<input type="radio"/>				
Investing in higher risk-high gain projects	<input type="radio"/>				
Engaging in international research projects	<input type="radio"/>				
Good career opportunities	<input type="radio"/>				
Attracting external funding	<input type="radio"/>				

---

19. Has the research environment at your Linnaeus Centre been characterised by a sense of:

	Not at all	To some extent	To a large extent	Completely	Not applicable
Trust	<input type="radio"/>				
Openness	<input type="radio"/>				
Engagement	<input type="radio"/>				
Curiosity	<input type="radio"/>				

20. How important has the Linnaeus Centre been for your research output, regarding:

	Of no importance	Of some importance	Important e but not crucial	Crucial	Not applicable
Publications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Registration of patents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
For the basic research performed in the project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
For developing new methods, guidelines or practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formation of a company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
New international partnership	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

21. Have you identified your self as being part of a Centre of Excellence during your period at the Linnaeus Centre?

- Not at all
- To some extent
- To a large extent
- To a very large extent
- Don't know/Not applicable

---

22. Would it have been possible for you to carry out the same type of research without being part of the Linnaeus Centre?

- Yes
- Yes, partly
- No
- Don't know

Please, feel free to comment you answer

23. How would you rate the quality of the Linnaeus Centre, regarding:

	Below national average	Nationally competitive	Internationally competitive	World leading	Don't know/not applicable
Research staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research output (publications or equivalent)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mangement and leadership	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support functions (i.e. administration, financial support)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please, feel free to comment on your answer

---

24. If there are further aspects from your time at the Linnaeus Centre that you want to share, please write your comment below:

---

Thank you for your response! You can now click submit and close the questionnaire!

## Survey to external advisors

The Swedish Research Council is currently performing a final evaluation of the Linnaeus grant. The Linnaeus grant was directed at developing centres of excellence (CoE) with internationally competitive research. For more information on the Linnaeus Grant and the evaluation, see [Final evaluation of the Linnaeus Grant](#).

You have received this questionnaire since you have been listed as an external advisor for a Linnaeus Centre named during the grant period. The questions are foremost directed at assessing the capacity building for enabling world leading research at the centre.

The first section of the questionnaire concerns general information about your involvement as an external advisor. The second section concerns your view of the Linnaeus centre as a Centre of excellence.

The information will be analysed as aggregate data and will not be able to trace back to you as a respondent. The response is therefore anonymous. You can read further about how the Swedish Research Council handles survey data below.

We are very grateful for your response!

The Linnaeus Evaluation team

---

Read about how the Swedish Research Council handles your personal data

---

Do you want to participate in the survey?

- Yes  
 No
- 

1. Please verify for which Linnaeus Centre you were engaged as an external advisor?

2. Please, mark the alternative that best describes your role as an external advisor for the Linnaeus Centre or similar.

- Formal member of advisory board, with regular meetings  
 Formal member of advisory board summoned on demand  
 Formal member of Steering Group or similar at the University, the faculty or the Centre  
 Formal role as advisor, not part of a board or group of advisors  
 Not formally appointed as advisor but, on occasions, involved in discussions on development of the centre  
 Don't know/not applicable

Comment

---

3. In the following list, we have listed different tasks relevant for your role as an external advisor. Please, indicate for which of these that you have been involved in for the Linnaeus Centre. (More than one alternative is possible.)

- Evaluation of individual grant proposals
- Evaluation of the centres overall progress
- Overall scientific quality assessment of the research at the centre?
- Strategic decisions
- Other, please specify

---

4. Have you been reimbursed for your work as an external advisor for the Linnaeus Centre? Please indicate below:

- Regular salary
- Compensation for specific tasks
- Compensation for costs (travel or similar)
- No compensation
- Don't wish to answer

---

5. During how many years were you engaged as an external advisor for the Linnaeus centre?

---

6. On average, how often were you engaged to advise the Linnaeus centre during your period as an external advisor?

7. Do you have the scientific background to cover all the research that was performed at the Linnaeus centre?  
Please, describe...

## Assesment of Center of Excellence

In the following questions we would like your opinion on what you consider important for the management and leadership at a Centre of Excellence (CoE). We also want you to assess to what extent those aspects have been present at your Linnaeus Centre.

8.

### Management and leadership - general

The aspects below are known features of CoE's, and we ask you to assess the importance of them for performing research at the highest international level. This question concerns management and leadership and we ask of your general opinion regardless of your actual experience or formal knowledge of CoE's.

In your opinion, how important is it that a Centre of Excellence should ...

	Not important at all	Not so important	Quite important	Very important	Don't know/Not applicable
... have a clear management structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a leadership-culture that fosters world-leading research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have clear objectives and targets for its scientific endeavour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a management that promotes a gender balance at all levels within the research workforce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... have a management that addresses gender equality and gender perspectives to ensure that research opportunities are equal for all eligible researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9.

Management and leadership at the Linnaeus Centre

This question concerns the management and leadership at the Linnaeus Centre where you were engaged as external advisor. We ask you to assess to what extent the aspects below was present when you were engaged.

In your opinion, to what extent has the Linnaeus Centre been characterised by the following:

	Not at all	To some extent	To a large extent	To a very large extent	Don't know/Not applicable
A clear management structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A leadership culture that fostered a world-leading research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear objectives and targets for its scientific endeavour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has promoted a gender balance at all levels within the research workforce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A management that has addressed gender equality and gender perspectives to ensure that research opportunities are equal for all eligible researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. How would you rate the quality of the Linnaeus Centre, regarding:

	World leading or equivalent	Internationally recognised/competitive	Nationally recognised/competitive	Undefined
Research staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research output (publications or equivalent)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Management and leadership	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support functions (i.e. administration, financial support)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please, feel free to comment on your answer

11. How would you rate the overall quality of the research performed at the Linnaeus centre?

- World leading or equivalent
- Internationally recognition/competitive
- Nationally recognition/competitive
- Don't know/not applicable

Please, feel free to comment on your answer!

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12. Was the funding arrangement of the Linnaeus centre satisfactory?

Please, describe...

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13. Any other comment?

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Thanks for your response! You can now click Submit and close the questionnaire!

The Linnaeus grants were presented as a new grant format in the Swedish Government's research policy bill 2004/05. The aim of the grant was to strengthen the ability of Swedish higher education institutions to prioritise and profile Swedish research to be internationally competitive at the forefront by building strong research environments. In total, the Swedish Research Council and Formas, have financed 40 environments. Each environment has received between 5–10 million SEK per year for 10 years.

This report presents the final evaluation of the Linnaeus Grant. Did the Linnaeus grants produce the desired effect? What have they meant for Swedish research?

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