Mittuniversitetet
MID SWEDEN UNIVERSITY

Work Plan 2016 – 2018

Research Environment for Transformative Technologies at Mid Sweden University

About our terminology
This is a short summary of the most important terms used in this document.

Research Action
Structured research project, program etc. that has specified goals, implementation plan and schedule.

Strategic Action
Strategically important Research Action. Currently we have four Strategic Actions; **e2mp, FORIC, EISS** and **KM2**.

Development Area
Initiative to build a new Strategic Action. Currently we have two Development Areas; **Measurement Systems** and **New Cellulosic Materials**.

Research Area or Competence Area
A research direction whose definition depends on context and can change with the evolution of science and technology. Thus Research Areas can overlap and do not correspond to the organizational structure. Currently we have two internationally recognized strong Research Areas, High-yield Pulping and Embedded Sensors, and one area, Nanomaterials Systems, where our goal is to reach such a status.

Research Group
Organizational unit that has a group leader. 17 research groups currently belong to our Research Environment. Each of the strong Research Areas is driven by one strong Research Group and supported by others.

Research Environment
In our case, this means the environment called **Transformative Technologies** formed by the two research centres STC and FSCN. This work plan concerns the development of the environment into one strong and coherent entity. The Knowledge Foundation supports this development with their funding program KK Miljö (KK Environment).

Core and Edge
Core refers to to the core business of our partner companies. Edge refers to areas of new businesses of these and other companies. Edge business is the driver of industrial transformation that Core business can enable.

Please note our notation: Research Actions are marked with bold font, key concepts with Capital Initials, and strategic goals with *italics and underlining*.

Mid Sweden University in partnership with

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Work Plan 2016 – 2018
Dnr: Mid Sweden University 2015/1939
Photo: Tina Stafrén
Feature: Processing of nanocellulose in the wood and materials laboratory,
FSCN Research Centre, Mid Sweden University
Print: Print Office, Mid Sweden University 2015

Executive Summary

The research centres FSCN and STC have joined forces in the Research Environment of Transformative Technologies. We are working systematically so that this environment will have nationally and internationally strong research program, resources and industrial collaborations. This will give the Mid Sweden University a clear research identity in technology and natural sciences. Towards the society, our purpose (mission) is to accelerate industrial renewal and regional growth in line with the vision *Transforming the Industrial Ecosystem* that the university has presented. Since 2011, the Knowledge Foundation has been supporting us through the program KK Environment (KK Miljö).

Last year we defined new goals for the 3-year period 2015-2017. The document at hand analyses the status with respect to these goals and presents a plan for 2016 and an outlook up to 2018. Since our research is organised under Strategic Actions (two of them still under preparation) we return to them throughout the Work Plan. The plan for 2016 contains the following main items:

- New research projects to improve our research program in the national and international competition. This includes eight KK Research Actions that match the development phase and critical needs in each of the Strategic Actions.

- Increased synergy with education development, for which two KK actions are proposed. In the strategic context of *TIE Vision*, education and competence development are important as a means to extend academic and industrial collaborations beyond current research projects, and more work in this respect is needed in the coming years.

- Recruitments and systematic preparation of future recruitments to secure continuity in strong Research Areas and increase force to areas where we want to become strong. In the portfolio proposed to the Knowledge Foundation, our focus this year is in adjunct professors. In our strategy process we have in several Strategic Actions reached a point where strong external support is crucial for the analysis of competition and extension of co-production.

- The development of co-production and industrial networks, where the status varies a lot between the Strategic Actions. Two of them have well-established networks of strong partners and the co-production evolves to cover their business needs all the way from the Core to Edge. Another two are in their nature broad platforms where we work to attract a growing number of companies to form dynamic networks for the industrial transformation. In the remaining two Strategic Actions we have the ambition to help companies to create business to areas where little business now exists. Our task is then to be the creator of sufficiently strong industrial partnerships.

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1 Introduction

The research centres FSCN and STC have joined forces in the Research Environment of Transformative Technologies. We are working systematically so that this environment will have nationally and internationally strong research program, resources and industrial collaborations. This will give the Mid Sweden University a clear research identity in technology and natural sciences. Towards the society, our purpose (mission) is to accelerate industrial renewal and regional growth in line with the vision *Transforming the Industrial Ecosystem* that the university has presented. Since 2011, the Knowledge Foundation has been supporting us through the program KK Environment (KK Miljö).

Our research is organised under the six Strategic Actions, two of them still under preparation:

- Manufacturing in industrial scale – **e2mp**
- Process control and monitoring – **EISS**
- Development Area **Measurement Systems**
- Competence development for regional renewal – **FORIC**
- Development Area **New Cellulosic Materials**
- Large surfaces for electronic functionality – **KM2**

The reason why we established the Strategic Actions was to create pressure towards increased synergies between Research Groups, and thereby towards a more powerful organisation. We did this even though in some cases precise research goals had not yet been formulated. In those cases we saw either a clear need from industry or a large potential for new business based on the Grand Challenges of the mankind. In the other cases we had a large ongoing Research Action that gave the first goals to the whole Strategic Action.

The great benefit of working this way is that we have all the time been able to run useful and increasingly ambitious research. We feel that the gradual sharpening of strategic goals is the best alternative in our case, where we are forming one Research Environment on the foundations of two very different research centres, FSCN and STC.

The drawback is that a lot of effort has been required to build shared understanding of where we are heading. Perhaps this would have been necessary in any case, given the starting point. The process of gradual sharpening is the reason why even in this Work Plan we elaborate on our strategic framework (Ch. 2) and describe plans for the strategy process next year (Ch. 8). The update of our vision and strategy documents was also recommended by the Knowledge Foundation Expert Group. In doing so, we have taken advantage of the expertise that our own Reference Group represents.

Last year we defined the following goals for the development of our Research Environment in the 3-year period 2015-2017:

- *Goal #1: Stronger research program[1] nationally and internationally*
- *Goal #2: Systematic development of personnel resources*
- *Goal #3: Broader and deeper co-production*
- *Goal #4: Efficient organization characterized by a well-functioning quality system*

The following chapters analyse the status and required next steps in order to implement the 3-year Plan. This time we also discuss the needs for development of education programs and competence programs (Ch. 4). Last year we focused on the collaboration with innovation networks. These two are, in parallel to research, important ways for the university to contribute to the fulfilment of the vision *Transforming the Industrial Ecosystem*.

[1] Note that we have changed the word "profile" to "program" in order to clarify the meaning of this goal.

2 Strategic framework

During this year we have, as suggested by the Knowledge Foundation Expert Group, worked to update and clarify our strategy documents. The updated description of the vision *Transforming the Industrial Ecosystem* hopefully makes it clear that reaching the vision will require not only leading research but also education programs and effective innovation systems that support the vision. To clarify our message we have decided that the research unit that the research centres FSCN and STC together form is called the Research Environment of Transformative Technologies. Through leading research we will attract people and international collaborations which also nurture our educational programs and the regional innovation systems.

Our research on Transformative Technologies gives the initial identity to the efforts of Mid Sweden University towards the *TIE Vision*. Later a broader engagement of the university is foreseen. For example, the need to be able to study business models is clear in the industrial graduate college **FORIC**. A good starting point for broader engagement of the university in fulfilling the *TIE Vision* is therefore to develop related education on the advanced and doctoral levels. A proposal for this is included in the portfolio of new KK Actions (Ch. 7). Strategic discussions about the collaboration have started with the Centre for Economic Relations at the Humanities Faculty.

Another step forward this year has been that we have merged the separate research strategies of FSCN and STC into one joint strategy (now in draft form). This has been part of an ongoing faculty-wide process to build research strategies for all the units that were assessed in ARC13. Our strategy for Transformative Technologies is connected to the intra-disciplinary strategies. No fundamental changes to our research directions have surfaced. Instead, the process sharpens and clarifies our goals. Sharpness is needed especially when defining the niches where our target is an internationally strong position in the academic research community, currently broadly defined as High-yield Pulping, Embedded Sensors, and Nanomaterial Systems (cf. Table 1 in the 3-year Plan 2015-2017).

With the choice of name, Research Environment of Transformative Technologies, we challenge ourselves to make it clear how our research in reality can contribute to the transformation of the industrial ecosystem. In the Work Plan 2015 we introduced the concepts of Core and Edge in order to be able to analyse our Research Program in this respect. This year we have clarified the usage of the concepts Core and Edge so that they only characterise the business challenge but not research. The point we want to make is that also research that improves Core business can be an important source for transformation. The strategy process will therefore lead to a refinement of the rough Core-Edge map given by Table 2 in the Progress Report 2015.

The work on research strategies is a continuous process. So far it has been mainly an internal process. Next it will be complemented with external industrial input and support to secure realistic assessment of our opportunities and clear contributions to vision *Transforming the Industrial Ecosystem*. The plan for this is described in Chapter 8.

3 Research program

Introduction

The first goal in our 3-year Plan 2016-2018 is to *build stronger research profile nationally and internationally*. Key instruments to fulfil this are our Strategic Actions and Development Areas**.** Three of these were built on strong industrial collaborations, **Energy-efficient mechanical pulping** (**e2mp)** with paper companies, and **Embedded Industrial Sensor Systems (EISS)** with energy and control systems companies (cf. Fig. 1). **Forest as a Resource Industrial College (FORIC)** connects several industrial sectors in an innovation network. These Strategic Actions have arisen from expressed industrial needs. The Strategic Action **KM2** and the Development Areas **Measurement Systems** and

New Cellulosic Materials stem from our ambition to build research prominence in new technology areas.

In the broad perspective, all our research is motivated by the Grand Challenges, such as climate change and resource scarcity, and technological drivers, such as information technology. The corresponding business opportunities have different names, such as "Bioeconomy", "Renewable Energy" and "Internet of Things". Strategic Actions form a process that transforms these opportunities to increasingly sharp research goals and, in parallel, continuously delivers solutions, knowledge and competence to industry.

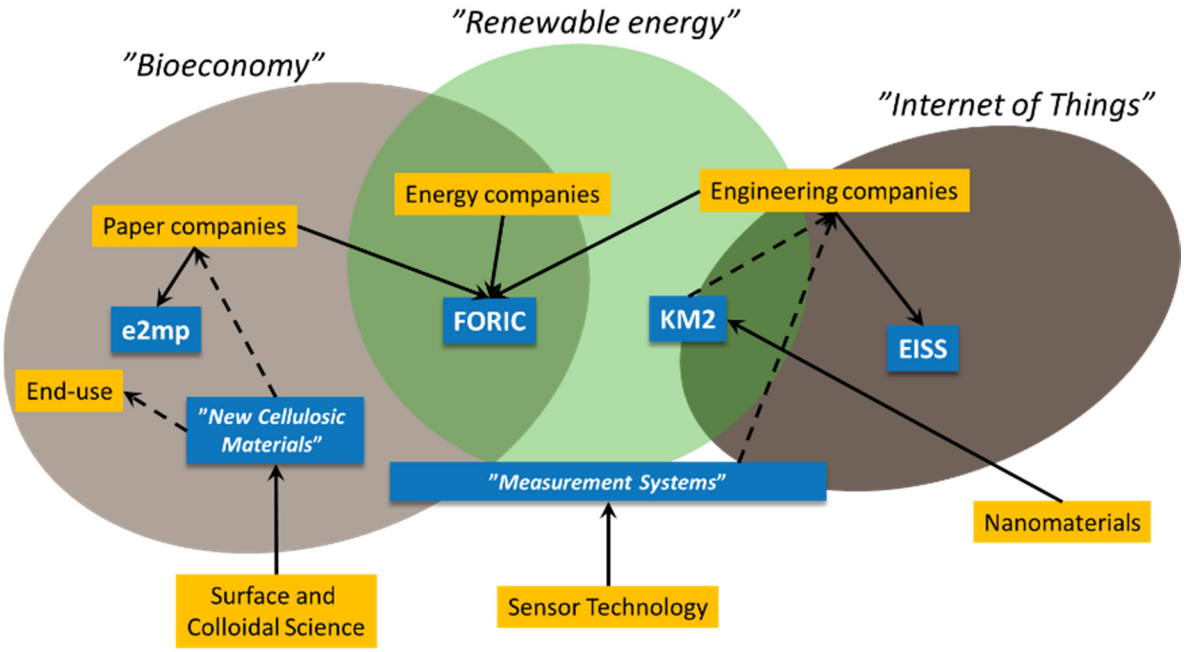

Figure 1. The connection of Strategic Actions with the expressed needs of selected industrial sectors (arrows from the top) and with our competences that could offer solutions to emerging industrial opportunities (arrows from the bottom).

The status and plans for each of the Strategic Actions and Development Areas are presented below. Clear positive development in terms of both approved and planned new projects is happening in **e2mp** with more generic focus and higher scientific ambition. International collaboration is growing in **EISS, Measurements Systems** and **New Cellulosic Materials**. For the last one we have identified a promising direction on which a Strategic Action could focus, but are uncertain if sufficient industrial interest can be found. **KM2** has encountered similar challenges, and there we must focus on building a good industrial network. The strategy development for **Measurement Systems** is proceeding well. One more Horizon2020 project has started in this area. Competitive funding from VR and FORMAS have been won to **FORIC**. A proposed education program related to **FORIC** would engage also other parts of Mid Sweden University in the work towards the vision of *Transforming the Industrial Ecosystem.*

Manufacturing in industrial scale – e2mp

The Strategic Action **e2mp** led by Prof. Per Engstrand is in the centre of our interaction with paper industry. The intensive co-production enables both improved competitiveness and industrial transformation. Continuity in the personal relations is crucial. We have therefore started the search of a candidate with industrial background to be recruited as a second professor in the pulp production area. We will also recruit new adjunct professors to maintain broad industrial networks.

The research in **e2mp** has the goal of improved efficiency in the manufacturing of today's paper and board products, which involves understanding the underlying fundamentals on the fibre materials. Energy savings in printing paper manufacture have been in the core of the **e2mp**. Research has now progressed to mill trials where we have demonstrated that it is possible to go from the 2011/12 benchmark of 1800 kWh/bdt for newsprint down to 1300 kWh/bdt. This is 200 kWh/bdt less than last year. In the case of CTMP for paperboard, pilot test results now indicate that it is possible to go as far as from 1100 kWh/bdt down to about 700 kWh/bdt.

With the new projects that have started this year the focus in the Strategic Action is increasingly moving from printing paper to packaging boards. We develop new CTMP technologies that reduce packaging weight. For the next year we propose a new KK Synergy project that broadens the technical scope and the industrial network. The new projects are made possible by the researcher capacity that becomes available when the industry-initiative **e2mp-i** ends now and the research profile **e2mp-rp** after next year.

Our goal with the Strategic Action **e2mp** is to secure our leading role in high-yield pulping (HYP) research world-wide. In the half-time evaluation of the Research Profile **e2mp** we were urged to build more fundamental research of high-yield pulping. In line with this, we now start a 3-year project funded by the Energy Agency where we develop particle modelling to understand the chip feeding and refining process. The science concerns better understanding of the physics, physical chemistry and rheology of the fibrous and fibrillar particles.

Another strategically important development is the growing interest from industry to collaborate with us on the use of nanocellulose in industrial manufacturing. One of the new projects is a HÖG proposal led by Prof. Córdova who brings valuable academic visibility to **e2mp**. The goal is to replace oil-based polymers in liquid packaging. For the first time the internationally-leading packaging technology company TetraPak is a partner in our projects. These plans mean that FSCN will gain a strong position at the nanocellulose[2] pilot facility that Holmen, MoRe Research and SP Processum are building in Örnsköldsvik. Our international position in high-yield pulping research is thereby further enhanced. As most of nanocellulose research elsewhere is focused on "exciting" new materials that are far from industrial manufacturing, our profile should be internationally interesting and give us opportunity to attract an international guest professor. We will investigate this already for the next Work Plan.

For the longer term, we are discussing with industry the options to build a KK Research Profile that would follow **e2mp-rp** and broaden the TMP and CTMP paths to an industrial pulping program. The idea could be to develop defibration processes that are tailored for different end-uses and optimised in manufacturing efficiency or process intensity. That would give new synergies between FSCN and STC, and in turn improve possibilities for European collaboration.

Process control and monitoring – EISS

The purpose of **EISS** is to change how industrial manufacturing processes are controlled and their condition monitored. The transformative technology base is formed by cyber-physical systems, wireless networks and connectivity through Internet of Things. The business potential is recognised at government level world-wide. Our strong competence in the area was initially created in the KK Profile+ action **STC Industrial IT** and further strengthened in partnership with ABB. The technology areas to be developed in **EISS** are robust wireless communication, energy harvesting in industrial environments, in-sensor processing architectures and methods, and internet connectivity.

The foundation of the Strategic Action is the KK Synergy **Autonomous Systems for Industrial Sensing (ASIS)**. We will build competence in the characterization, modelling and evaluation of energy harvesting and storage in industrial environments; develop methods for low-latency and

[2] More specifically crystalline nanocellulose (CNC), also called nanocrystalline cellulose (NCC)

predictable communication; and analyse the needs and requirements for in-sensor embedded processing. Finally, quantitative analysis of computing architectures will lead to a proposal for suitable architectures.

Two recruitments to support **ASIS** are proposed in the new KK Portfolio, the adjunct professor Johan Åkerberg from ABB and the guest professor Emiliano Sisinni from Brescia University. A complementary HÖG project has also been planned to improve time- and mission-critical communication. This was identified as a key problem in robust wireless communication in the **Robust** project that ended this year.

In the area of Internet of Things (IoT) we see an increasing industrial interest. We have started a HÖG project in the area of smart grids, and now apply for a KK Prospect for a new assistant professor. We are also collaborating with the City of Sundsvall on the applications of IoT in "smart cities". This has led to a large project plan (**SMART**) submitted to the European Regional Development Fund. The key idea is to combine embedded sensors and communication technology to smart systems and services in three areas, Smart Cities, Efficient Production and Smart Wind Power. SMART will also strengthen co-production in **EISS** and thereby enhance our impact to the implementation of the *TIE Vision*. Here we also have good potential for funding from the Energy Agency and Vinnova.

Our goal is in 2017 to apply for a KK Research Profile in the area of **EISS**. On the way there we will need to recruit more adjunct professors and guest professors in the coming years.

Development Area Measurement Systems

Over the years we have accumulated strong expertise in various aspects of measurement technology. Together with **EISS**, this area is motivated by the transformative power of information technology. In the *TIE Vision* IT is identified as a key enabler of transformation. The purpose of the Development Area **Measurement Systems** is to determine the best way for industries and ourselves to benefit from the cumulated competence and to secure our internationally strong position. Our goal is therefore to build a coherent research agenda in order to form a Strategic Action. The challenge lies in the large number of application areas that draw in different directions. For the Research Environment the broad applicability is a great asset in the pursuit of new industrial partners with Edge business. Support to other Strategic Actions is also most valuable.

So far, most of the research projects have focused on the measurement needs in industrial manufacturing processes. One project characterizes moving surfaces and another one wood chipping processes. The latter has led to research and education collaboration in Trondheim. A third HÖG project investigates BIG data analysis methods for large sets of sensor data for the purpose of extracting higher-level knowledge of processes and other industrial activities. This project connects **EISS** and **Measurements systems.**

In the area of detectors, we were granted a Horizon 2020 project that develops neutron detectors for the new European Spallation Source (ESS) built in Lund. Because of industrial interest, we propose two new detector projects, one on the characterization of nanocellulose and the other on a new X-ray configuration for surface characterization. The second one is initially only for one year in order to determine the best way for the company to proceed.

This year we have done extensive work to formulate the strategic direction for **Measurement Systems**. In order to strengthen the process we propose to recruit Consolatina Liguori from the University of Salerno as a guest professor. In order to broaden our industrial network we propose to recruit Jan Andersson as adjunct professor. We also propose a new HÖG project that will function as a precursor of the Strategic Action. This project is a step towards a new system where environmental parameters are integrated into the process control of industrial production. The goal is to measure the interaction of living creatures with production facilities, specifically the interaction of birds with wind power stations. Another component is included in the **Miljöhorisont** project (see under **FORIC**) where we develop real-time characterization of industrial waste.

Our target is to form the Strategic Action next year. In the implementation phase we will need to widen co-production through the recruitment of more adjunct professors and build strong international cooperation through the recruitment of more guest professors.

Competence for regional renewal – FORIC

The industrial graduate school **FORIC** led by Prof. Per Engstrand is the kernel for a growing network of different projects that together form the Strategic Action. Like the graduate school itself, these projects study various value chains and new business opportunities around the core of pulp, paper and timber manufacturing. Interactions between these projects and the regional innovation clusters BioBusiness Arena and Processum build an innovation network that drive transformation of the industrial ecosystem with focus on "Bioeconomy". In other words, the Strategic Action does not have a transformative technology agenda but rather a business transformation agenda. Competence development on analysing and leading change is therefore equally important as is technology development. This is why in the new KK Portfolio (Ch. 7) we have an application to support development of such an education program at the Master level.

The graduate school started this year and is already showing good results, with a publication rate above what was planned. We have decided to prepare an application for a second intake of students to start in 2017 for next WP.

A majority of the Research Groups in FSCN and STC are directly involved in the graduate school. The projects around it involve projects on the manufacture of liquid fuels and energy from biomass, the cleaning of dissolved metals from water and green chemicals extracted from wood. New funding to these projects has been acquired among others from VR and FORMAS. It is also very gratifying that after many years of search for industrial interest, we have companies involved in the preparation of projects for bioenergy and biofuels. Closely connected to **FORIC**, environmental monitoring is developed under **Measurement Systems**.

In parallel with Transformative Technologies, a faculty-wide initiative **Miljöhorisont** has been built. This effort joins a large number of research groups to strengthen the university's research profile in the environmental area. We believe that this approach will work better than the original vision we had in 2012, where environmental technologies (under the theme Clean Environment) were confined to our Research Environment. A broad network of industrial and public partners in the regions of Jämtland/Härjedalen and Västernorrland are committed to the initiative.

Looking forward we expect the business transformation agenda to strengthen among others through educational collaboration with the university´s Research Centre for Economic Relations. Stronger collaboration with the Processum cluster in Örnsköldsvik is also our goal, especially concerning biofuels. Joint project applications are planned. In three years' time the cities of Örnsköldsvik, Härnösand and Sundsvall should have important roles in the Strategic Action.

Development Area New Cellulosic Materials

We initiated the Development Area **New Cellulosic Materials** in order to identify areas where we have a chance to build a strong research program that can help the paper industry to develop new offerings to the growing market of renewable materials in different end-uses. In the beginning, our projects focused merely on the physical properties of paper materials (including two HÖG projects in the Complex Materials group). The idea was that these projects would give understanding which later will be needed when we actually develop new materials. Now we have two projects in the BioInnovation program, a short pre-study on paper yarns and a strategic project on textiles led by Swerea, and a European project on the plastization of paper. Together these projects will demonstrate how paper can be made textile-like or plastic-like by chemical treatments in a converting process. Partners in these projects are in part outside paper industry, which is important. The purpose of

demonstrations is to solicit interest in versatile product sectors in order to help us identify realistic application areas.

The crucial asset for this development path is the expertise we have in the Surface and Colloidal Engineering Group led by Prof. Magnus Norgren. His group is strong academically and has a good personnel profile which would allow internationally competitive research on environmentally-benign water-based solvents and plasticizers of cellulose, fibres and paper. The strategy development within Chemical Engineering leads to the same conclusion. We can also see a good synergy with the Complex Materials Group with respect to industrial conversion processes.

If we select this path of environmentally-benign conversion processes as the core of a Strategic Action, then we will add Surface and Colloidal Chemistry to the list of areas (see Table 1 in the 3-year Plan 2015-2017) where we want to reach a strong international position. However, this depends on whether or not the research direction we are thinking about has enough industrial relevance. Two years should be enough to find out. The HÖG proposal on delignification in the KK Portfolio (Ch. 7) is a crucial step because it is the first application of the kind of solvents we would like to study in a Strategic Action. We have also submitted four applications to VR and FORMAS and are partner in fifth, but these involve no industrial partners. However, based on these plans we know that we can build a strong and internationally attractive academic research program in this area. International collaboration especially with Portugal and, on the highest academic level, with China is already growing. It is only the industrial network that takes more time to build.

Large surfaces for electronic functionality – KM2

The grand vision of this Strategic Action is to be able to produce low-cost solutions for the harvesting, storage and different uses of electrical energy with efficient roll-to-roll processes. Manufacturing processes (coating and printing) and products of paper industry are the foreseen basis for efficiency and the rapidly developing nanomaterials as enabler of the desired functionalities. Within Transformative Technologies the action consolidates parallel research paths on “printed electronics” that both STC and FSCN have previously pursued. The obvious industrial justification for the Strategic Action is the expectation that the market for renewable energy systems will grow, especially in carbon-free electricity production.

Based on the above logic, and additionally motivated by excellent ARC13 assessment we launched the Strategic Action **KM2**. The first projects work on (1) manufacturing of large functional surfaces, (2) technology for hybrid and fully electrical vehicles, and (3) for large-area positioning. The cluster of projects for the vehicle sector is the strongest part of **KM2**, both regarding industrial networks and funding base. It includes projects on supercapacitors for the storage of braking energy, and compact and efficient converters to drive the electrical motor.

The development of the manufacturing methods suffers from the fragmentation of relevant Swedish industry. In the ongoing with focus on solar cells, we have laid out an agenda for the process steps that are needed for energy storage and harvesting materials. Four smaller technology companies are involved (in addition to two paper companies) but clearly broader network is needed. In the new KK Portfolio we therefore have the recruitment of an adjunct professor from ACREO to connect us to relevant Swedish companies and innovation networks. Industrial perspective is also a critical help to the sharpening of our focus in the manufacturing area so that we can find our competitive niche.

In order to attract more technology companies to the network we also propose a KK Synergy action. It will add force to the development of the manufacturing platform and support the other projects in the Strategic Action. The third important improvement will be the establishment of a Materials and Innovation Laboratory next year. It will offer facilities for materials characterisation to companies and bring together research in one place. It will also be used to increase international collaboration and projects in the coming years. This last point is crucial so that we can establish a strong position in nanomaterial systems, as we have set as our academic target.

4 Development of Education

The education programs of Mid Sweden University serve at least three functions in the fulfilment of the vision *Transforming the Industrial Ecosystem.* First, education and research naturally benefit from each other. Strong areas of research rely on education programs as a recruitment pool but also help education to adjust to changes in technology and labour markets. Earlier we had very little education in areas connected to the forest and related industries where we have strong research. The faculty has therefore worked systematically to strengthen the 3-year program of Energy Engineering and now started a 5-year program in Engineering Chemistry.

We also improve the synergy between research and education through new programs at the Master´s level, especially using the Master-by-Research concept. Starting next year, we will revise the Master program in electronics (**SANDAS** in the KK Portfolio, Ch. 7) so that it better reflects our research in **EISS** and **Measurement Systems,** and the expectations of industrial employers. One year later another development connected to **e2mp**, **FORIC** and **New Cellulosic Materials** will be launched so that it is ready for the 5th year of the students in the Engineering Chemistry program, starting fall 2019. Later a third new program related to the Internet of Things will also be needed.

In Engineering Physics we already have a Master-by-Research Program in operation that supports the Strategic Action **KM2**. However, here we need better adaptability because the broad range of fast developing technologies. On-line courses and programs are a good solution for this especially since E-learning is a focus area in the education strategy of the university. We will prepare applications to the Knowledge Foundation to develop both MOOC courses and a full on-line program (the NU call). This will engage the disciplines of Electronics, Computer Science and Engineering Physics.

The second contribution of education to the *TIE Vision* is through dynamic competence development of industry employees so that companies can better adjust to technology development and market changes. Through the **FLEX** project we already opened the Master-by-Research path for industry employees and the ongoing industrial research college **FORIC** does the same at the licentiate and doctoral level. To secure that we really meet the changing needs of industry, also at the undergraduate level, the faculty has formed a council for employers in the IT Sector and is creating one for the area of Resource Efficiency.

Thirdly, education is important for the *TIE Vision* in that education programs are a good way to initiate inter-disciplinary and cross-sectorial collaboration. Broader competence base than just engineering is needed in the study and development of new business models and value chains that are the essence of industrial transformation. We will therefore next year develop a new Master programme focused on change in complex industrial systems (**OCXIS** in the KK Portfolio). The program will be a collaboration of several disciplines that currently are at most weakly engaged in our research, such as Quality Management and Industrial Design. Also the Research Centre for Economic Relations of the Humanities Faculty will participate.

5 Personnel and other resources

Recruitments for Strategic Actions

Systematic development of personnel resources is the second goal in our 3-year Plan 2016-2018. The personnel resources of our Research Environment of Transformative Technologies consists of experts in Chemical Engineering, Chemistry, Computer Science, Electronics and Engineering Physics. They are grouped in 19 Research Groups that form various constellations in the Strategic Actions. Aside from PhD graduates who have left, no major changes have occurred in the groups. For 2016 we plan to recruit 3 new adjunct professors, 1 adjunct assistant professor from industry, and 2 international visiting professors with the support of Knowledge Foundation and prolong an existing. These recruitments strengthen the Strategic Actions **EISS**, **Measurement Systems** and **KM2** in international

profiling and strategic planning. In the coming years, we will keep up the pace in recruiting new adjunct professors, especially to bind additional large companies to our research.

Regarding full-time professors, by 2018 we plan to recruit one more Chemical Engineering professor with strong industrial experience to secure the industrial networks in **e2mp**. Two new full-time professors with some "materials science" background, i.e. Chemical Engineering or Engineering Physics will be necessary for robust research programs in **New Cellulosic Materials**, and **KM2**. The latter two recruitments will be balanced by two retirements by 2018, one in Chemical Engineering and another in Engineering Physics. We have not yet determined exactly how these recruitments are directed. A full-time professor recruitment to Electronics will start in 2018, also balanced by a retirement, to strengthen research in both **Measurement System** and **KM2**.

Mid Sweden University has started a career program for junior faculty, with ten participants from our Research Environment. This program will contribute to increase the outwards international mobility of our staff. However, the goal of stronger research profile requires a significant increase of international guest professors and visiting post-doc researchers within the next three years. Strong international interaction is vital for competitive research in areas of fast technology development. Since industrial partners in emerging technology areas often are small, the relatively simple binational exchange programs are an important financing source that we shall learn to make better use of.

This year we have had 52 doctoral students. Among others, **FORIC** plans to enrol additional 16 students in the beginning of 2017 so the total number of graduate students is expected to increase to 60 by 2018. New external funding is expected to allow also the recruitment of some new post-doctoral researchers to each of the Strategic Actions. Summarizing the future outlook, we expect a modest 10% growth of our full-time personnel and doctoral students from the current 150 to 160-170 persons by 2018.

Research facilities

During this fall and next year we will collect instruments needed for **KM2** in a new Materials and Innovations Laboratory. This includes also new instruments. An industrial reference group will be established to secure maximal benefit to the regional industry. Investments has started for new equipment and facilities to better meet the needs for the Strategic Actions **EISS**, **Measurement Systems** and **KM2**. This includes a new laboratories for Embedded Vision and Wireless Networks, an upgrade of the laboratories for Wireless Measurement Systems and Radio and Power Electronics.

Another important development will happen in Örnsköldsvik. Next summer we will move the Digital Printing Center, DPC, to the premises of MoRe Research Ab and establish it as a local node of Transformative Technologies in the areas of cellulosic materials and industrial manufacturing. The laboratory and pilot facilities of MoRe Research and SP Processum will be used in **e2mp** (e.g. nanocellulose), **FORIC** (biofuels) and **New Cellulosic Materials** (dissolution of cellulose). We see good opportunity for stronger collaboration with the local bio refinery cluster. The main offering of DPC will be optical and printability characterization of surfaces. The instruments for printing of functionality we will consolidate to the Materials Innovation Laboratory in Sundsvall.

6 Co-production and industrial networks

The third goal in our 3-year Plan 2016-2018 is *Broader and deeper co-production*, both regionally and nationally. The Strategic Actions **e2mp** and **EISS** have the tradition to work in close and intensive collaboration with large companies, e.g. ABB, Bosch Rexroth, SCA, Holmen, Stora Enso and Valmet which have strong Core businesses. In comparison, **FORIC** and the Development Area **Measurement Systems** have their starting point in the broad networks that have formed over time with different kinds of companies, both the large and smaller whose businesses often are entirely of the Edge type, e.g. SenseAir, PulpEye, Combitech and ShortLink. The starting point for the Development Area **New**

Cellulosic Materials and the Strategic Action **KM2** was that we believe that with research we can help companies to exploit emerging business opportunities (cf. Fig. 1). However, this creates a special challenge to build industrial collaborations.

Figure 2 summarises how we see our industrial networks to develop and thereby drive transformation. In the areas characterized by predominantly strong industrial partners, deeper co-production means not only more research to improve efficiency (the Core) but also collaboration in business transformation (the Edge). Positive progress in this sense is demonstrated for example by the collaboration within **e2mp** to drive industrial manufacturing of nanocrystalline cellulose at the new pilot plant in Örnsköldsvik. In essence, this kind of deep co-production that ranges from Core to Edge, *or vice versa*, is the result of a long-time partnership. We cannot "force" it, but we can work systematically to make it attractive.

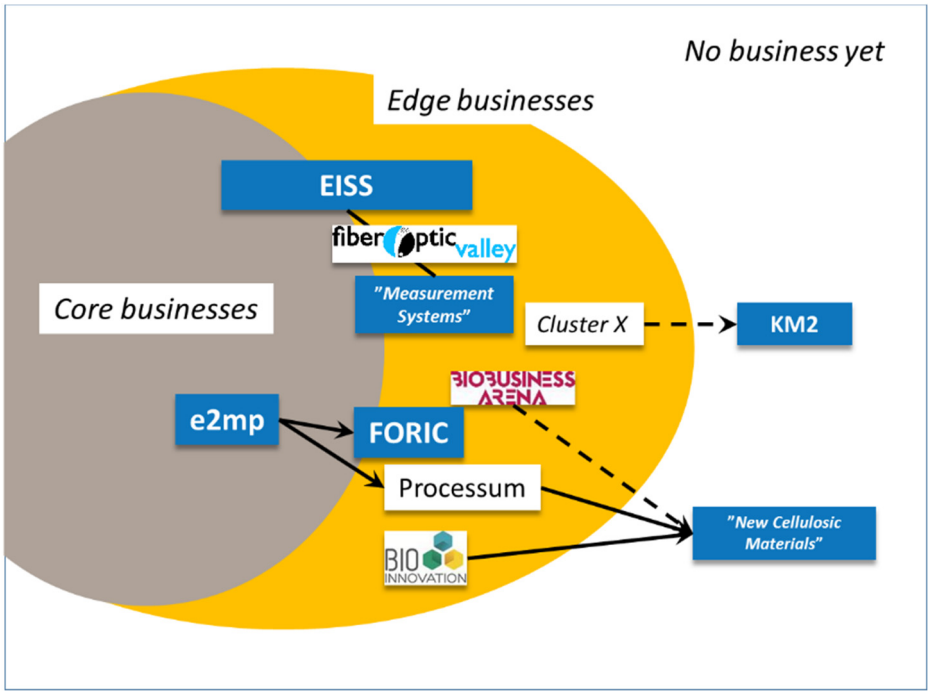

Figure 2: The effect of our industrial networks and co-production on driving transformation. The solid arrows show existing and dashed arrows needed pathways to form strong transformative partnerships.

In accordance with the 3-year goal, we are also making good progress to build broader networks that drive transformation, and we will keep working on that. The regional innovation clusters Fiber Optic Valley, Bron, BioBusiness Arena and Processum have an important role in this. The share of research for Edge business involving new partners is now close to 30% and equal to the share of research on Core business with our well-established partners. Last year the corresponding numbers were 24% vs. 38%. The wide range of different kinds of industrial partners and business motivations enforces an open and dynamic culture of co-production throughout our research environment.

Systematic support to industrial competence development and a relevant selection of educational programs are important ways for the university to complement research in creating conditions that increase deep co-production and attract new companies. The recruitment of international guest professors, adjunct professors and young exchange researchers works in the same way. The portfolio of new KK Actions (next Chapter) contains several proposals in both areas.

7 Portfolio of KK Actions

Follow-up of finished and current KK Actions

Two projects have ended since this the Progress Report 2015:

- **Robust** made a large impact on the implementation of the Strategic Action **EISS**. ABB became a strategic partner in the development of **EISS** and we recruited Mikael Gidlund as a full professor. The technology investigation was a success and resulted in several publications and guest editorials. *A deviation from the plan* was in the way the salary was payed. This affected the economic reporting of the project but did not deviate from the agreement.
- **Plenocap** (Penoptisk infångning och beräkningsbaserad fotografering) had three effects: large academic production, a European network that became a Marie Currie project, and a well-trained young researcher who will work in **Measurement System**.

Two projects report 4-6 months delays, one (**Light-weight Composites**) because of equipment problem and the other (**Fibre Network Design**) because of administration problems.

The Quality Process for the new KK Actions 2016

The development of new actions started with a kick-off in December that included strategic discussions. After input from companies, researchers generated 25 drafts for new project proposals. The Reference Group and Management Group ordered two more actions in order to balance the use of different KK instruments. Of these 27 drafts, 20 passed to the project proposal stage, but three were later withdrawn. In the end 14 projects passed quality evaluation during the summer and fall, some after revisions. Because of critical reviews, additional two HÖG projects were cut to one year and included in the portfolio in order to test the idea. If that proves successful, these projects continue the in Work Plan 2016. The Reference Group has verified that all the new projects are in line with the *TIE Vision*. The evaluation and strategic relevance of each new KK Action can be found in our BOX Folder.

The distribution of the actions between the Strategic Actions is shown in Figure 3. The proposed KK portfolio consists of five recruitment actions, one ProSpect, two AVANS, five HÖG and two Synergy. The last two are submitted to the separate evaluation by the Knowledge Foundation.

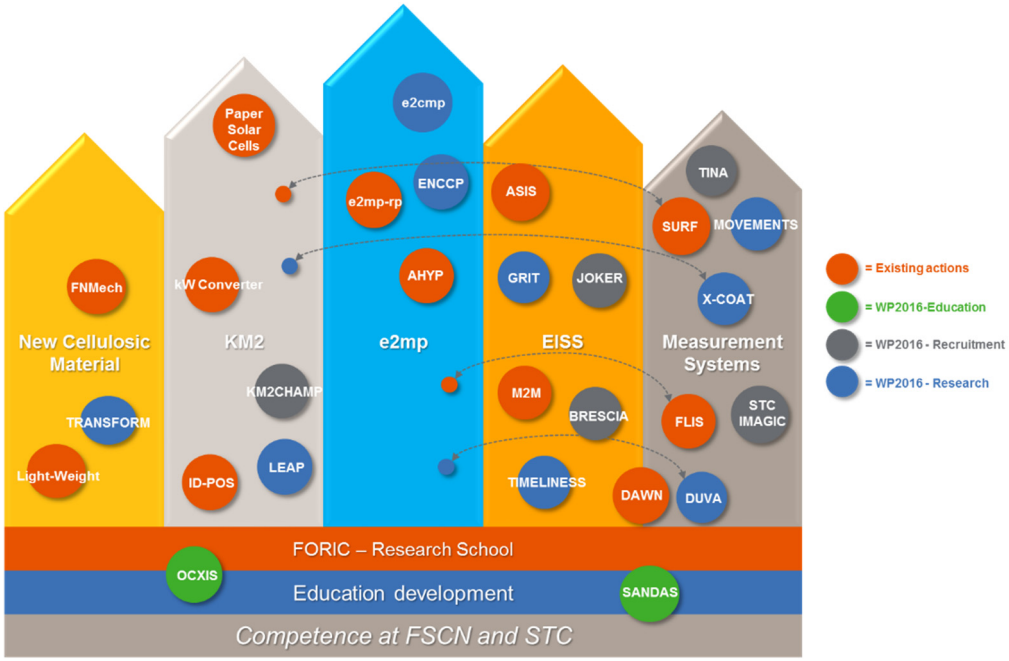

Figure 3. Existing and proposed new KK Actions in our research program. Red colour denotes the current actions, blue the proposed Research Actions, grey the recruitment proposals and green the educational proposals.

Motivation for the new KK Actions

The new KK Actions are divided into three categories depending on their importance for the profiling, strategic direction and co-production of our Research Environment. In the first category are the actions that we consider decisive and therefore critical in the current development phase of the Strategic Actions, in the second actions that in an important manner increase volume, in the third category actions that are of very good quality but make a proportionately smaller impact.

Priority 1: Critical actions

In this category we request funding for three recruitments of adjunct professors (Strategic Knowledge Enhancements) and four HÖG projects. Three of our Strategic Actions are in a situation where industrial perspective and networks are critically needed for us to be able to sharpen the strategic direction:

- **Adjunct Professor Mats Sandberg (KM2CHAMP)** – from ACREO to the Strategic Action **KM2** for his broad networks and strong technological competence in printed electronics
- **Adjunct Professor Jan Y Andersson (STCIMAGIC)** – with background from ACREO to Development Area **Measurement Systems** for his wide industrial networks and expertise in detectors
- **Adjunct professor Johan Åkerberg (JOKER)** – is one of the leading actors in the area and will build closer collaboration with ABB in the Strategic Area **EISS**

Three of HÖG projects are planned to lay the foundations for the new Strategic Actions that are under development:

- **New process to produce delignified pulp based on mechanical pulp as raw material (TRANSFORM)** – to Development Area **New Cellulosic Materials**. Initiated by industry, this is the first study on certain chemicals that can dissolve and plasticize cellulosic fibres. Such conversion processes of cellulose will probably to be central in the Strategic Action that will follow. If successful, the technology enables mechanical pulping mills to start the manufacture a pulp that substitutes chemical pulp after relatively small investments.
- **Method for Cost Optimized Volumetric Object Monitoring Systems (MOVEMENTS)** – to the Development Area **Measurement System**. This project is a test for technology that we believe will give a good foundation for the Strategic Action. The specific case investigated is the characterization of interactions that living creatures have with production facilities, specifically the inventory of birds at planned sites of wind power stations.
- **Detector and method development in the UV and EUV wavelength region, for application in processing industries (DUVA)** – to the Development Area **Measurement System**. Initiated by companies, this project develops UV-detectors for the characterization of nanocellulose. This is an area of growing industrial relevance and requires new competence. Here we see very good prospects for a Horizon2020 project and continued collaboration with CERN. This is excellent in view of our ambitions to increase the international collaboration.

The fourth HÖG project responds to the recommendations in the half-time review of the Research Profile **e2mp:**

- **Eco-friendly engineering of nanocrystalline cellulose for "green" packaging (ENCCP)** – to strengthen **e2mp** with more fundamental studies and higher scientific visibility. We develop applications for the nanocrystalline cellulose from the new pilot plant of Holmen. It is very valuable for us to gain a position in the industrial manufacturing of NCC. This is also the first time that the internationally leading company Tetra Pak invites our researchers to a project.

Priority 2: Important actions

In order to strengthen the established Strategic Actions, we propose two SYNERGY projects (**LEAP** and **e2cmp**), a HÖG project (**TIMELINESS**), a Strategic Knowledge Enhancement (**BRESCIA**) and an AVANS project (**SANDAS**):

- **Large-area Electronics Platform (LEAP)** – to **KM2** where the fragmentation of industry is the biggest challenge. **LEAP** is an important step to include in the network companies from more well-established sectors who see applications for the manufacturing technologies. It significantly strengthens the Strategic Action **KM2** by adding force to the research on energy harvesting, and superconductors that have started earlier with other financing.
- **Eco friendly efficient chemimechanical system for sustainable packaging materials (e2cmp)** – to move the focus of Strategic Action **e2mp** from printing-paper focus towards the manufacturing of fossil-free packaging materials less on printing papers. Strategically valuable is also the internal collaboration that strengthens the fundamental content and raises the scientific visibility of **e2mp**, as suggested in the half-time review.
- **Time- and Mission-Critical Communication in Low-Power Wireless Networks (TIMELINESS)** – to investigate the lower level mechanisms of robust communication in industrial wireless sensor networks, which is one of the central challenges in the Strategic Action **EISS**. The project also strengthens cooperation with ABB and starts cooperation with the world-leading chip manufacturer for industrial wireless sensor networks, Analog Devices.
- **International Guest Professor Emiliano Sisinni (BRESCIA)** – will build stronger international networks for the Strategic Action **EISS**, specifically with University of Brescia. Sisinni will be a strong resource in both in-sensor processing and wireless sensor networks.
- **Master of Science in Sensor and Automation Systems (SANDAS)** – to renew the Master programme in Electronics Systems with new focus on Sensor and Automation Systems. The resulting program will bridge the core activities of process industry to the Strategic Actions **EISS** and **Measurement Systems**. This will improve the attractiveness and quality of the programme and build a stronger relation to our co-production partners.

Priority 3: Good actions

Following smaller actions are also of very high quality:

- **International guest professor Consolatina Liguori (TINA)** – to the Development Area **Measurement Systems** will bring new high-quality competence to image-based measurement systems and initiate cooperation with the University of Salerno.
- **Operation and Change of Complex Industrial Systems (OCXIS)** – an AVANS application that starts collaboration with research centres and academic disciplines that are outside of Transformative Technologies but that can nevertheless strengthen MIUNs efforts to fulfil the *TIE Vision*. OCXIS is unique in that it helps large organisations, usually characterized by strong Core business, to handle change, i.e. the Edge of their business.
- **Characterisation of layered structures by a combination of X-ray fluorescence and Compton imaging (X-COAT)** – a one-year HÖG project to the Development Area **Measurement Systems**. The purpose is to evaluate the potential of the combination of X-ray fluorescence and Compton scattering methods for the characterization of surface materials and the underlying structure.
- **Distributed Green Services on the Internet-of-Things (GRIT)** – the Strategic Action **EISS.** With this Prospekt action we can establish a new assistant lecturer in the field of communication in Internet of Things (IoT) who will also build competence and strengthen the Research Group with IoT competence.

Summary of KK Actions 2013-2019

Appendix A shows the funding from the Knowledge Foundation to the Strategic Actions and education development has grown. The effect of the proposed new KK Actions is also shown. The preliminary plans that were specifically discussed in Chapters 3 to 5 are indicated in grey but not counted to the total volume per Strategic Action. In the coming years we will continue to prepare also other projects, recruitments of adjunct and guest professors, and education development actions based on the opportunities and ideas that ongoing projects and co-production give rise to.

8 Efficient organization

Strategy process 2016

Goal #4 in our 3-year Plan is *Efficient organization characterized by a well-functioning quality system*, and particularly important is to engage researchers in strategy development. The ongoing process has been driven in a number of separate internal workgroups. This is necessary because of the breadth of disciplines. The biggest challenge in the internal process is recognize where new knowledge and competence will be needed and where at the same time we can be a preferred supplier.

The second component in the strategy process consists of learning activities that go across the Research Environment. We are already running the joint Business Innovation Seminars to expose researchers to the strategic thinking of industry leaders. A new activity that we will launch is thematic learning seminars. The idea is to involve researchers from different areas to elaborate on a specific opportunity. For this purpose we will initiate learning seminars where researchers from different areas and external guests discuss selected topics. Such seminars will connect to the development of Strategic Actions.

The existing boards of large KK Research Actions form a natural source of external support for the strategy process in **e2mp**, **EISS** and **FORIC**. In **e2mp** we have an especially good position as the trusted supplier of industrial pulping knowledge to Swedish paper companies and as one of the few research organisations in the world that work on high-yield pulping. In this area the industrial networks can guide our research so that it stays competitive, and no other planning efforts will be run in 2016.

As the global R&D competition is very intense in information and materials technologies, the challenge of making wise choices is especially big for **KM2**, **EISS** and **New Cellulosic Materials**. Attractive industrial partners operate internationally and therefore we must build and perform internationally competitive research in these areas. For **EISS** we have set up an internal strategy workgroup and help is available through the strong international companies represented in the steering group of the KK Synergy action **ASIS**. In **New Cellulosic Materials** we do not yet have any major Research Action, but we benefit from the BioInnovation program[3] that promotes national strategic collaborations. The Steering Group of FSCN also helps us with their insights about the national and international research in the area. The need for external support is largest in **KM2**. Here the industrial structure is still to emerge and our partners are mainly young smaller companies. We will therefore run a strategy and future scenario process with external input. Our goal by the end of 2016 is to specify sharp targets for our positioning in **KM2**, **EISS** and **New Cellulosic Materials**.

The strategic and competitive challenge is relatively less in **FORIC** and **Measurement Systems** since they are broad platforms with large numbers of potential industrial partnerships. More than our research, the relevant strategic questions concern the evolution of the region as an industrial ecosystem. Our plan is therefore not to restrict research topics for now, and then in 2017 reconsider the

[3] BioInnovation is funded by Vinnova, Energy Agency and FORMAS

situation. We expect that the dynamic nature of these two Strategic Actions will increase our researchers' understanding of business development at the ecosystem level.

Coordination of education development

Good coordination between research and education is important for the fulfilment of the *TIE Vision*. Changes in research, industry and society imply changes in the needs for competences and hence in the educational programs. In the faculty we are therefore striving to form complete academic environments with balance between education and research. We have had a serious imbalance in favour of research in areas related to forest and other process industries but the situation is now improving (cf. Chapter 4). The faculty has also started councils ("branschråd") for the IT Sector and the Resource Efficiency area in order to secure that the education portfolio is relevant to industry.

Separate organisations have caused difficulties to the work to complete the academic environment of the education portfolio of the faculty and the Research Environment of Transformative Technologies. The maintenance and development of the undergraduate education portfolio is steered by its own organisation within the faculty and follows the education strategy of the university. An educational program is run by a department. Before a program can be opened for enrolment it has to pass the quality control of the faculty board, fulfil legal requirements, and finally be approved by the vice chancellor. Departments must wait for the final approval before they are allowed to develop the courses. The development cycle is normally over two years long. During this process, and once the program is established, the department have full responsibility for all parts of the process and later for administrating and maintaining the program.

Up to this year we in the Research Environment have ourselves initiated and run the development of education programs that we have seen need for. We will further clarify the connection between the planning processes of the education program and research. In the annual planning process of the Research Environment we will assess the need for new programs three years forward. The appropriate departments together with the faculty determine how these needs and others, e.g. those from the industrial councils can best be fulfilled. Our Research Environment can support the development of new programs with resources and funding.

Communication plan

In external communication the most important change this year has been the structural clarification of research at the Mid Sweden University. Instead of "profile areas" (such as IT and Digital Services), the strong Research Areas are now defined by the research centres (such as FSCN and STC). The identity of our Research Environment of Transformative Technologies is also an important step towards communicational clarity. Communicating that identity will be part of our ongoing work to increase the visibility of our research, in line with the 3-year Plan 2015-2017. We are currently also working on three international conferences that STC could arrange in Sundsvall.

Also in the regional level, FSCN and STC must be perceived as the initial core of the contribution from Mid Sweden University to the *TIE Vision*. The increased visibility of the close synergies and interaction with the innovation clusters BioBusiness Arena, Fiber Optic Valley, Bron and Processum will help in that. The same is true for our collaboration with the cities of Sundsvall and Härnösand. Here we have work to do together with the cities to raise the visibility of these collaborations.

The biggest challenge in the internal communication is to increase the engagement and understanding for our own strategic development and likewise the business development in the industries that we work with. This means strengthening the importance of Business Innovation seminars and launching the future scenario process.

The quality system and portfolio administration

The work with the quality system has focused on continued consolidation and on internal communication of the system. Emphasis have been on continues revisions and improvements. The major improvements are the following.

- The role of the Reference Group is set with reoccurring meetings over the year. The close and continuous dialogue between Reference Group and management has above all strengthened the strategic and quality processes.
- The quality process for project proposals for the European Regional Development Fund has been fully developed and implemented. The process is similar to the process developed to evaluate project proposals for the Knowledge Foundation, including external peer review of the proposals to ensure high scientific quality and impact on regional growth.
- Timetables, forms and templates, and instructions for the process of developing, evaluating and selecting new actions for the Work Plan have been routinely revised. The yearly schedule, descriptions of the process, are now available on an internal website.
- The strategic and administration meeting processes have developed to be more regular and thus provide better monitoring of ongoing processes.
- In 2015, representatives from the three Knowledge Foundation Environments at Mid Sweden University, Halmstad University and University of Skövde met twice to share experiences and compare best practices. Next meeting is scheduled to August 2016 in Halmstad.

For next year, the following developments and improvements are planned:

- An overall approach will be taken to revising forms, templates and instructions this year so that they will become more similar with respect to approach and structure. The instructions to external reviewers will be similarly reviewed.
- Following the experiences with evaluating proposals for European Regional development Fund, a hearing will be arranged before sending project proposals for external review. We also plan to follow up on formalities earlier in the process. This is to be able to identify deviations in time, ensure that the personnel planning is reasonable, that the information of the call is being followed etc.
- An external review group with members from academy will be established to improve the base for selecting and deciding which new actions will be included in the next Work Plan. The review group will support the management in all aspects, scientific, strategically and co-production, in the final process of selecting new actions.

9 Funding

We have had both success and problems with external funding this year. The gap in support from the European Structural Development Fund has extended from 2014 to 2015 because the new program has in the first call excluded areas appropriate for us. On the positive side, new international funding has roughly doubled from last year to SEK 2.4 million and new opportunities for international collaboration have been identified. A large volume of funding applications has been submitted to Swedish Research Councils. Some funding have already been won but most of the decisions will come later this fall. Overall the funding outlook for coming years is positive.

The applications in the new KK Portfolio that we propose correspond to a total of SEK 46,6 million. The distribution of the funding for 2016-2018 is shown in App. B.

Appendix A: Portfolio of KK Actions 2013-2019

Appendix B: Budget proposal to Knowledge Foundation

Ongoing actions	2016	2017	2018
e2mp-rp	3 991 385	900 805	-
FORIC	3 012 000	2 817 000	1 512 000
Paper Solar Cells	1 828 064	470 804	
Light-weight Structural Composites from Fibre-based Materials, Reliability Design	1 389 220	233 149	
FLIS - Characterization of wood disintegration processes	1 001 609	234 764	-
kW Converters - High Frequency Medium Power Isolated Converters	747 662	189 341	-
ID-POS - Large Areas for RFID Identification, Positioning and Interaction	1 016 110	217 804	-
ASIS -	2 950 460	3 019 636	3 090 743
DAWN - Data analytics in (Wireless) Industrial Networks	1 354 808	1 328 513	346 868
SURF - Ytkarakterisering av industriella produkter med stora areor	1 278 535	1 322 935	324 574
AHYP - Advanced HYPfor Paperboard	2 005 000	505 001	-
M2M COM - Reliable and Secure M2M Comunication in Smart Grid Networks	1 348 954	1 294 349	339 625
FNMech	916 046	938 932	77 783
	22 839 853	**13 473 033**	**5 691 593**
OH coverege in activities, 20 % OH coverege for all actions	*4 567 971*	*2 694 607*	*1 138 319*
Quality system, 3% extra OH coverage for new actions from 2014	*685 196*	*404 191*	*170 748*
Total funding approved actions	**28 093 019**	**16 571 831**	**7 000 659**

New actions	2016	2017	2018
OCXIS - Operation and Change of Complex Industrial Systems	882 866	883 938	233 196
SANDAS - Master of Science in Sensor and Automation Systems	667 146	859 170	130 771
BRESCIA - International Guest Professor Emiliano Sisinni	112 600	57 800	
KM2 Champ - Adjunct Professor in Printed Electronics	431 573	528 182	87 417
JOKER - Adjunct Professorship for Johan Åkerberg	200 850	297 730	307 198
STC-IMAGIC - Adjunct Professorship for Jan Y Andersson	440 570	539 282	89 313
TINA - Guestprofessorship for Consolatina Liguori	211 553	70 518	
DUVA - Detector and method development in the UV and EUV wavelength region, for application in processing industries	957 492	1 386 938	1 360 968
ENCCP - Ecofriendly engineering of nanocrystalline cellulose for "green"-packaging	1 124 401	1 319 774	1 292 800
MOVEMeNTS - Method for Cost Optimized Volumetric Object Monitoring Systems	1 003 072	1 199 276	1 248 940
TIMELINESS - Time- and Mission-Critical Communication in Low-Power Wireless Sensor Networks	982 000	1 477 700	1 361 000
TRANSFORM - New process to produce delignified pulp based on mechanical pulp as raw material	1 015 200	184 800	
X-COAT - Characterisation of layered structures by a combination of X-ray fluorescence and Compton imaging	820 550	263 368	-
GRIT - Distributed Green Services on the Internet-of-Things	440 802	604 012	155 186
e2cmp - Eco friendly efficient chemimechanical system for sustainable packaging materials	2 250 677	3 000 903	3 000 903
LEAP - Large-area Electronics Platform	1 398 919	2 739 742	2 813 983
Proposed total funding from KKS, OH not included	**12 940 271**	**15 413 133**	**12 081 675**
OH coverege in activities, 20 % OH coverege for all actions	*2 588 054*	*3 082 627*	*2 416 335*
Quality system, 3% extra OH coverage for new actions from 2014	*388 208*	*462 394*	*362 450*
Total funding, new actions	**15 916 533**	**18 958 154**	**14 860 460**

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