PROGRESS REPORT 2014

PROGRESS REPORT OF THE KK RESEARCH ENVIRONMENT AT MID SWEDEN UNIVERSITY

FSCN

PART OF MID SWEDEN UNIVERSITY

stc Sensible Things that Communicate

PART OF MID SWEDEN UNIVERSITY

Executive Summary

KK Research Environment is a crucial instrument of the Mid-Sweden University in its function as development engine, covering 40% of its research. Our vision in the research environment is to enable *Industrial Transformation* in co-production with companies and public infrastructures. The focus on transformation implies that we consolidate our research towards new products and services.

This report covers the period from spring 2013 to spring 2014 in the development of the organization and research program. It also reports the research results achieved last year and preliminary plans for new KK Research Actions. The progress is compared against the goals defined in the 3-year plan for 2012—2014. Together with the results of ARC13, the analysis presented here will be the starting point in the new 3-year plan for 2015-2017.

The organization has improved significantly during the last year. The scope of the KK Research Environment is now sharply defined, the organization structure defines clear responsibilities and the management processes integrate the two research centres, FSCN and STC. Further development is especially needed in the processes for strategy development and communication.

The research program is structured around the Strategic Actions **e2mp**, **FLEX**, **FORIC**, **EnergyWiser** and **KM2**. The development of **EnergyWiser** and **KM2** are in-line with the 3-year *Goal 1 Stronger research profile and higher quality*. We continue to build strong industrial and academic networks with international visibility for these initiatives. Regarding the overall quality of our research, work also remains to be done to publish more in high-quality journals and improve the quality of doctoral education.

The second important goal in the development of the research program is *Goal 2 Increased synergies and stronger competences of FSCN and STC*. We have made significant progress in increasing the synergies. Three of the Strategic Initiatives (**FLEX**, **FORIC**, and **KM2**) and many of the current projects and new proposals are joint actions of FSCN and STC. Concerning the respective competences of FSCN and STC, we have identified three important areas that we will work on. The targets are not yet ready.

Regarding *Goal 3 Quality of co-production,* progress has been made in the support to industrial competence development (**FLEX** and **FORIC**) and in broadening the industrial network of FSCN. FSCN's Steering Group has been revised, and **KM2** has started to bring in companies that sell materials and products for Renewable Energy Systems. **EnergyWiser** has attracted strong international companies to work with STC. In total, we have reached essentially all the specific targets defined under *Goal 3*.

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Note on the notation: Research Actions are marked with **bold font**, key concepts with Capital Initials and strategic goals with *italics and underlining*.

1. Improved organization

A strong research environment cannot be developed without an efficient organization and strong leadership. We have therefore established a new organization for the KK Research Environment. The organization includes functions for strategic development, quality evaluation, editing reports and plans, administrative coordination, and communication (see Chapter 1.2).

The targets of the KK Research Environment in the 3-year plan and corresponding results are:

- *Goal 1 Stronger research profile and higher quality*
  - Increase the proportion of publications in high-quality journals: Our productivity in publications was regarded as very good in the ARC13 Evaluation. Chapter 3.2 highlights some projects that performed well.
  - *Systematically improve the quality of doctoral education*: The process has been started under the leadership of the Faculty Board and in collaboration with colleagues at Karlstad University. The examination procedures have been evaluated and changes been made for the Licentiate degree (Chapter 1.3).
  - *Communicate clearly the strategy and identity of the KK Research Environment*: We have in place a communication function(Chapter 1.2) to secure clear understanding internally and externally of the identity (Chapter 1.1).
  - The specific targets and results that concern the research program are discussed in Chapters 2.1 and 3.
- *Goal 2 Increased synergies and stronger competences of FSCN and STC*
  - The specific targets set for this goal concern only the research program and are discussed in Chapters 2.2 and 3. In particular, we have many Research Actions and plan several new that strengthen the synergies within the KK Research Environment.
- *Goal 3 Quality of co-production*
  - *Recruit adjunct professors in green products, processes and intelligent services*: The number of adjunct professors has gradually increased from 6 in 2011 to 10 in 2013. Section 5 in Appendix B gives the names.
  - *Broaden FSCNs Steering Group to other materials and bio-energy*: This has been done (Chapter 1.2).
  - *Offer industrial PhD students a coherent environment*: This will be delivered by the graduate school **FORIC** (Chapter 2.3).
  - *Secure the delivery of competence to industry through 8-10 researchers with licentiate or doctoral degree*: Last year 15 researchers left the university after receiving their degree (Chapter 1.4).
  - *Clear structures for the follow-up and evaluation of results, actions and strategies*: Most of this has been in operation since 2013. The revision is currently implemented (Chapter 1.3).
  - The relevant research results are discussed in Chapters 2 and 3.

1.1. Sharp scope

The Mid Sweden University is located in a region that is world leading in forest industrial development and one of Sweden's best as winter a sports and outdoor environment. Strategic development has to relate to the current strength and at the same time challenge the existing paradigm by transforming competences and skills towards new needs in the society. The KK Research Environment is a crucial instrument of the Mid Sweden University in its function as the engine for regional and national development of renewable products and efficient industrial processes that are compatible with the IT age.

During the last half a year we have worked to build a shared and clear picture within the university about the scope of the KK Research Environment. The process to communicate and create understanding internally is still in progress.

The KK Research Environment covers all the work of the research centres FSCN and STC. This puts the focus on engineering and technologies that are applied to existing or new industrial processes or public infrastructures. The common thread through the research is our TIE Vision of *Industrial Transformation*. We see ICT as a key enabling technology for this. Another crucial technology development is the manufacturing of new materials which challenges traditional paradigms and will definitely drive industrial transformation. The industrial opportunities offered by forest resources are an important but not exclusive starting point in our research on new materials. When developing new research initiatives we are thus not restricted to a certain industrial sector or market segment as we know it, but rather want to address transformative opportunities that are most exciting from a global perspective. Having said all this, we have deliberately not defined the scope using academic subjects or disciplines. That is important because we can build strong research profile only by combining our forces, which requires cross-disciplinary, inclusive and inspiring transformative themes for the research.

The focus on industrial applications means that collaboration with companies is a central part of all our research. In addition to all KK Research Actions, even most of our other projects involve industrial co-production. The evolving interests of our industrial partners strongly influence the evolution of our research program. In accordance with the international positioning expressed in the TIE Vision, it is however also important for us to pursue ambitious intra-disciplinary academic research that triggers new applications, attracts talented researchers and enables international collaboration.

Many of the research groups of FSCN and STC are involved also in projects that are motivated by other reasons than industrial or infrastructural relevance. This includes especially programs that support regional development or raise the local recognition of Mid Sweden University. This engagement is again in line with the TIE Vision. For example, we are involved in the development of consumer applications of ICT that are not directly motivated by industrial or infrastructural relevance. The inspiring impact that these collaborations make on our KK Research Environment is analogous with that of intra-disciplinary academic research.

Finally, the many of the Research Actions included in the KK Research Environment naturally involve also other MIUN research groups (see e.g. **FORIC**) and external research groups (see e.g. **e2mp** and **KM2**). See Chapter 2.

1.2. Management structure

A new management structure for the KK Research Environment was implemented in the beginning of 2014; see the organization chart in Fig 1 on the next page. In the new structure the responsibilities are clearly divided into processes. Each process has a working team that involves the faculty, research centres and central administration (for communication). These processes are described in Chapter 1.3.

In forming the new management organization care has been taken so that FSCN and STC are integrated into the common management structure and use the same processes. The coordinator of the KK Research Environment is the Dean of the Faculty for Science, Technology and Media, Prof Hans-Erik Nilsson. The management processes of the KK Research Environment are managed by STC director Prof Mattias O´Nils. Prof Kaarlo Niskanen from FSCN acts as strategic editor and is responsible for vision documents, annual reports, work plans, strategies and goal formulations. The external quality evaluation process is managed Dr Maria Torstensson from the faculty administration.

The evaluation process includes external review of project proposals and final reports. A team of administrators and communicators provides support in both internal and external processes.

With the new organization a common culture is developed within the KK Research Environment. The next step is to form also common external platform with yearly communication events, workshops and conferences. Such development is in progress. The first KK Research Environment external workshop is scheduled in October, 2014. The Strategic Initiatives **FORIC**, **EnergyWiser** and **KM2** that are shared between FSCN and STC provide a good platform for such events.

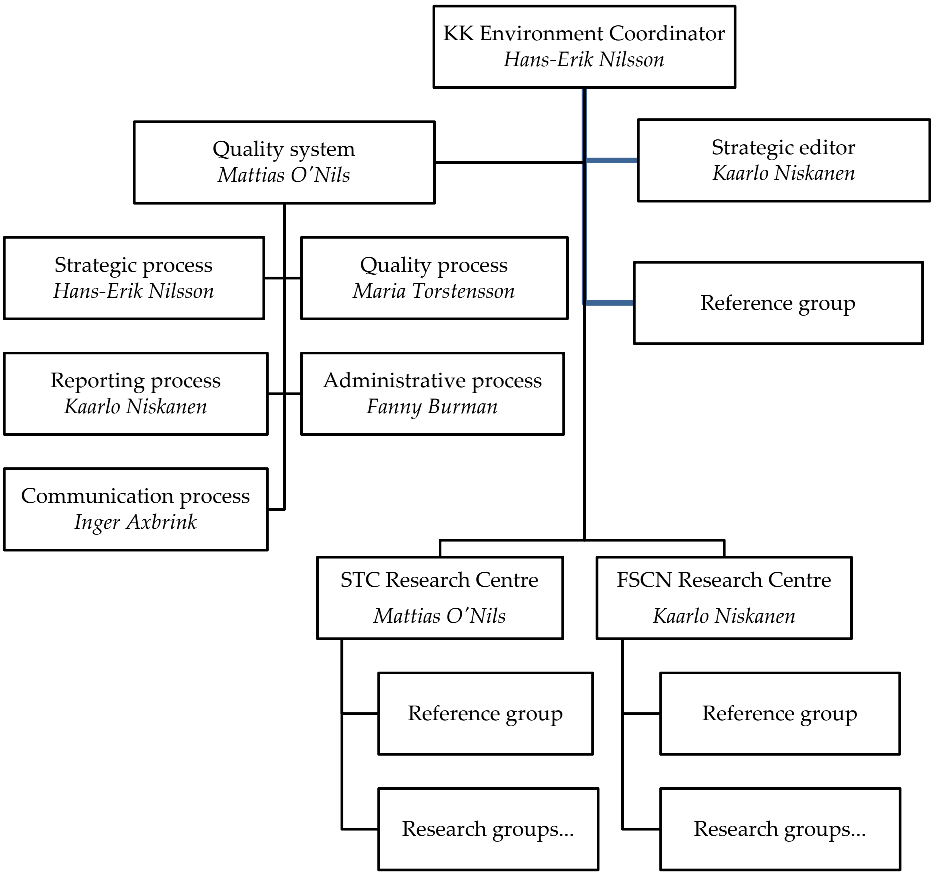


Fig 1 Organisation chart of the MIUN KK Research Environment

In 2014 we have formed an external reference group for the whole KK Research Environment. The reference group includes two members from each of the research centres and two distinguished international researchers. The reference group acts as mentor and evaluator of strategies and work plans of the KK Research Environment. Additional improvements that will be done during the year are mainly to fully establish the reference group. The reference group members are:

- Örjan Petterson, President, SCA R&D Centre, FSCN
- Rickard Andersson, Vice President Bio Technology and Environmental Systems, Valmet AB, FSCN
- Jonas Wallberg, Director ICT, Teknikföretagen, STC
- Johan Åkerberg, Global Research Area Coordinator, ABB Corporate Research, STC
- Prof. Danny Crookes, Director of Research, Speech & Vision Systems Cluster, Queens University Belfast
- Prof. Janne Laine, Dean of the School of Chemical Engineering, Aalto University, Finland

The internal regulation at the Mid-Sweden University demands external reference group for each research centre. Thus, STC and FSCN have their own external reference groups. FSCN has had its reference group (called FSCN Steering Group) since year 2000. Given the recent emphasis on renewal and transformation, the members no longer represent only the papermaking industry but also biomaterials. The new members are Rickard Andersson (see above) and Pernilla Walkenström (Department manager Textiles and Plastics at Swerea IVF). Örjan Petterson and Göran Bengtson (Stora Enso) continue until their retirement later this year. Also the internal representation was revised accordingly to include Professors Engstrand, Uesaka, Norgren, Edström, Olin and Niskanen.

STC became a research centre in 2013 and until end of 2013 had reference groups related to the profiling actions (KK Profile and KK Profile+). From 2014 STC has a centre based reference group composed of the external representatives; Jonas Dahlström (Fiber Optic Valley), Jonas Wallberg (Teknikföretagen), Johan Åkerberg (ABB Corporate Research). The internal represents are Prof. Bengt Oelmann, Prof. Mikael Gidlund, Prof. Christer Fröjdh and Prof. Mattias O'Nils. The latter constitute STCs management group. This new composition of the reference group will be evaluated next year.

1.3. Management processes

The quality development process has gradually been developed and implemented. This development is an ongoing process where methods and tools are iteratively enhanced. The key activities implemented so far are review of project proposals and final reports, as well as formats for reporting and internal evaluations. In addition the admission procedure for graduate studies has been revised in order to better support the administrative needs of the industrial graduate school.

The KK Research Environment revised quality system is re-organized from 2014 (Mattias O'Nils is responsible) and it is devided in five different processes:

- **Strategic process** *(Process leader: Hans-Erik Nilsson):* Develop the strategy and implementing the strategy.
- **Quality process** *(Process leader: Maria Torstensson):* Ensuring quality in new and ongoing activities.
- **Reporting process** (*Process leader: Kaarlo Niskanen*): Reports to KK foundation
- **Administrative process** *(Process leader: Fanny Burman)*: Supporting the other processes, i.e. keeping track and updating of documents, templates, document storage and support.
- **Communication process** *(Process leader: Inger Axbrink):* Planning and handling internal and external communication.

Below the process improvements which has been implemented since last report is indicated for each process.

The **Strategic process** has been strengthed in many aspects since the last report. The two main improvements are that the person responsible for the strategic development is also now responsible for the whole KK Research Environment and for the establishment of the reference group for the whole KK Research Environment. Both these improvements increase the quality both in the strategic development and implementation. In the implementation part of the strategy process, the initiation of new project has now been merged into **one process instead of the two separated processes** for STC and FSCN last year. Additionally, the process now has elements of both top-down comissioning of projects and a bottom-up approach to suggest new projects.

The **Quality process** has developed to now also include formal evaluation of ongoing and ended project that is handled in the KK Research Environment. This includes method description of evaluation processes and reporting templates for both ongoing and ended projects. This year we will develop formal descriptions of all parts of the quality process and include the reference group into the strategic quality assurance of the new proposed projects.

In 2013-2014 all research actions have been subjected to quality evaluation according to the established process. This means that after selection of which projects to be developed, all projects where scientifically evaluated by at least two peers and two other evaluating the coproduction and industrial relevance of the project. The projects which did not meet all the quality requirements were given a chance to revise and submit it for a second review. All projects except one passed this process and were then included into the Work Plan (WP) together with the review result. In the WP the projects were prioritized by the management group for the KK Research Environment. We discuss in Section 3.2 the results and deviations of the KK Research Actions running during 2013.

An appropriately adjusted version of the quality review process is also applied to all project proposals that are submitted for KK Foundation outside the KK Research Environment. Another version is offered as a support to proposals for VR funding. The VR support process includes seminars with researchers with experience from the VR councils, and a peer review process consisting on internal collegial discussions and external pre-evaluations.

The examination routine for the Licentiate degree has been revised by the Faculty Board. The evaluation procedure has been synchronized with the procedure for the doctor degree. An examination committee with external members is also introduced for the Licentiate degree. During 2014 the obligatory graduate study courses will be updated and evaluated against general goals for graduate studies in Sweden as well as towards updated internal goals within the faculty.

The main improvement of **Reporting process** is to assign an editor who is a part of the management of the KK Research Environment and its research, Kaarlo Niskanen.

During the last year, the **Administrative process** has been integrated into the new organization of the university, including engaging the faculty administration into the KK Research Environment and to build interfaces to the new central administration of the university. The main detailed improvements are developed in a common communication strategy according to the KK-foundation and a structured document handling/storage system. During this year, we will fully document the connection between process descriptions and assign a process leader for this process.

Communication process is basically a new process in the KK Research Environment quality system. As a result of the university’s reorganization and revised research centre organization, the university has instituted a communication officer responsible at each research centre. This improves the visibility of the research centres and will also give resources to communicate the KK Research Environment as well. During the year, an initial KK Research Environment web has been developed and a two day KK Research Environment conference is planned in October in cooperation with the innovation support systems Fiber Optic Valley (FOV) and Bio Business Arena (BBA). The conference will be a part of both the strategic development of the whole KK Research Environment and also an opportunity for getting input on relevant research challenges using the same model as AIM Day in Uppsala. This year will be focused on developing a communication strategy for the KK Research Environment.

1.4. Resources

Here we discuss the development of personnel, infrastructure and financing. The data is given in Appendix B. The turnover in of KK Research Environment in economic terms has in recent years been ca. 40% of the research of Mid Sweden University. The total personnel, infrastructure and funding have not changed significantly since 2011. We have primarily adjusted the organisation to the economic challenges that the university faces. This together with the organizational changes is the first step to a situation where new recruitments can again be made. During the coming three years several senior-level retirements will occur and strategic recruitments will thus be important. The focus will be on recruitments that support the stronger research profile of the KK Research Environment.

The research groups of the two centres are given in Appendix C. The collaborations between the groups and engagement in the Strategic Actions of the KK Research Environment (cf. WP 2014-2016) are also shown. The engagement may happen through direct participation or through related projects. One can clearly see how the Strategic Actions build coherence within the entire Research Environment. It is naturally to continue working towards increased consolidation of our research. This requires competence development in areas that can bridge the Strategic Initiatives.

Personnel development

At FSCN we have been very conservative with recruitments. Earlier, several research groups moved into FSCN. They have definitely strengthened FSCNs research but some also enhanced the economic challenges. In 2013 the number of permanently employed researchers increased at FSCN from 27 to 32. This happened in the junior level where employments were made permanent. On the senior level the number of professors has not changed since 2011. A guest professor (Bo Westerlind) was hired from SCA R&D. He is working with the Colloid and Surface Engineering and Complex Systems groups. The number of graduate students continued to grow, from 22 in 2011 to 28 last year. This year we expect a third of them to finish their studies and leave for external employment.

In 2013, the number of STCs permanently employed researchers increased from 29 to 31. On the senior level one professor retired and one new professor was promoted (Mårten Sjöström). At the end of the year Prof Theo Kanter moved to Stockholm University and was replaced by Mikael Gidlund. The number of graduate students has decreased, from 32 in 2012 to 29, and will decrease further since there were 11 PhD students that graduated in 2013 and several more will finish this year. Thus, recruiting new graduate students will be a large effort during 2014.

In addition to research, the faculty is strengthening the education programs in energy systems and in automation and therefore need new recruitments that also contribute to the research of the KK Research Environment.

The plans for future personnel development are explained in the new 3-year plan. The recommendations of ARC13 are an important part in the planning.

Research funding

The external funding of the KK Research Environment has increased slightly during 2013. This can be attributed to an increased number of funding sources. This has been very important during 2013 as the EU regional funding was significantly lower than 2012. This intermission in the program shows up also in the budget for 2014. The new regional program is expected to start in the spring of 2015. A decrease in funding from KK Foundation is also notable during 2014. During 2011 and 2012 the faculty funding was temporary increased due to a reallocation of internal savings to research. These extra resources ended ending in 2013. New resource will be released during 2014 from the university board within a strategic program to strengthen the research. The strategic program will be formed utilizing the recommendations in the ACR13 evaluation.

The success rate in funding applications is as expected. However, funding from research councils (VR, FORMAS) should increase. During 2014 an adjusted version of the quality system in the KK Research Environment has been used to support applicants for VR projects.

In 2013, the researchers in STC made 26 large and small applications from different source, a total of 21 million (42%) where approved. A larger project on ice prediction on wind mills from Energy Agency was approved. A few larger EU projects were also approved, mainly focused on further develop distributed systems that preparing for the next funding period. For the smaller projects approved, it is notable that projects from VR and ÅF where approved.

For FSCN a new funding source has been the Energy Agency that now funds our research on paper-based storage of electricity. This is included in the **KM2** Strategic Initiative. Faculty funding has decreased since 2011. After some pause, a smaller international EU project (**COMPAC**) was approved in the end of 2013 to work on the plasticization of cellulose. This is an important component in the development of "New Cellulosic Materials" (Chapter 2.2).

Research infrastructure

No major changes have happened with the research equipment or facilities.

2. Strategic development of research

MIUNs goal is that the KK Research Environment will give the university a clear identity and recognition nationally and internationally in engineering and natural sciences. The research program is the main steering instrument we have. In the TIE Vision document of 2012 we presented thematic research areas as a way to describe the common areas of our research. However, the themes do not say much about the focus of research. In the Work Plan 2014-2016 we therefore decided instead to use Strategic Actions to specify the positioning and goals for our research. Compared with the general themes, the Strategic Actions have precise focus and explicit content. The significance of the Strategic Actions is summarized in the following Table.

Strategic Action	Contribute to goals	Strong research profile in	Co-production with	Industrial Transformation towards	Strengthen the organization through
e2mp (running)	*Goal 1, TIE 2, TIE 5*	Mechanical (high-yield) pulping	Paper industry and suppliers		Coproduction with key industrial partners
FLEX (running)	*Goal 3, TIE 1, TIE 4*				Master-by-Research for industry personnel
FORIC (starting)	*Goal 2, Goal 3, TIE 1, TIE 3*		Paper, energy, infrastructure	Bioeconomy	Synergy FSCN-STC; Study environment for industrial PhD students
EnergyWiser (in preparation)	*Goal 1, Goal 3, TIE 2, TIE 5*	Embedded sensors	Energy, infrastructure, process control	Renewable energy systems	Coproduction with key industrial partners
KM2 (in preparation)	*Goal 1, TIE 2, TIE 5*	Electronic nanomaterials and functional surfaces	Equipment manufacturers	Renewable energy systems	Broaden co-production: Synergy FSCN-STC; Consolidate physics and mathematics groups

The table refers to the 3-year goals for 2012-2014 agreed with the KK Foundation and the long-term goals in the TIE Vision (see Appendix A):

- 3-year *Goal 1 Stronger research profile and higher quality* corresponds to *TIE 2 Leading*
- 3-year *Goal 2 Increased synergy and stronger competences* corresponds to *TIE 1 Resources*
- 3-year *Goal 3 Quality of industrial co-production* concerns organizational development

The Strategic Actions also contribute to the other long-term goals, *TIE 3 Start-ups*, *TIE 4 Education* and *TIE 5 International*.

In this chapter we discuss the progress in our research program towards the strategic goals. The following discussion can be summarized by noting the important development challenges. These are related to the Strategic Initiatives **EnergyWiser** and **KM2**, and certain areas of competence development. For both **EnergyWiser** and **KM2**, we must be able to build strong international academic visibility and collaboration in addition to the strong applied research in co-production with industry. Stronger international collaboration is also recommended in the ARC13 review. **KM2** also needs a much stronger industrial network whereas **EnergyWiser** already has a good industrial network with strong international partners. In competence development that falls outside the current Strategic Initiatives we identify three areas where sharper goals are needed:

- Measurement Technology that can have transformative applications and/or increase internal synergies
- Industrial Communication Systems that can drive industrial transformation
- "New Cellulosic Materials" that would be needed for internal synergy and can drive industrial transformation

2.1. Goal 1: Stronger research profile and higher quality

In the 3-year plan we defined two research areas where we want to build stronger profile, *Embedded sensors for efficient energy production and use*, and *Consolidation of 1-2 areas for Advanced Paper Materials*. In the Work Plan 2014-2016 the corresponding Strategic Actions were defined as **EnergyWiser** and **Large Functional Surfaces.** The latter (instead of **Advanced Paper Materials**) was chosen in order to increase opportunities to incorporate also STCs research groups in the initiative. In the Work Plan **e2mp** was also identified as a Strategic Action.

The Strategic Action **e2mp** is part of our research on Mechanical Pulping. In this area we are the leading research institution in the world. In the current 3-year plan we have therefore not defined any further development target for mechanical pulping. The time for that comes when **e2mp** begins to approach its end. The goal of **e2mp** is to reduce the use of electrical energy in mechanical pulping by 50% and hence improve resource efficiency. With this Strategic Action we aim to maintain the international leadership we have in this area, in line with *TIE 5 International*. Funding currently comes primarily from KK Foundation and Energy Agency, but the initiative also has a Norwegian sister project with national funding. Last year we finished a large complementary project **Filling the Gap** that focused on the fundamental mechanisms of mechanical pulp refining. This project was funded by Vinnova that included collaborations with Chalmers, University of British Columbia and VTT (Finland). **Filling the Gap** indicated the need for improvement in specific process measurements.

The Strategic Initiative **EnergyWiser** corresponds to the 3-year goal that we will build a nationally leading position in the use of embedded sensors for more efficient and environmentally-friendly energy production and use. This action builds on the foundations laid in the regional research program **EnergyWise** that ends March this year. The preparation of the KK Research Profile **EnergyWiser** is in its final stages. The contribution to the transformative TIE Vision comes from embedded sensors that enable safe and efficient new energy systems, especially solar and wind. In the energy use, embedded sensors that drive resource efficient control of industrial processes and also that this technology enables outsourcing of process control, which is a large new business opportunity. Funding for this Strategic Action comes from KK Foundation and Energy Agency.

One of our critical challenges is to employ the competences that we have for the renewal of forest industry. During the last year, a strong research program **KM2** emerged as a Strategic Initiative that *replaces* the earlier initiatives **Advanced Paper Materials** and then **Large Functional Surfaces** with concrete content and focus. In **KM2** the goal is to develop paper-based materials for ubiquitous solar cells, functional surfaces, batteries and other devices. If successful, we will thereby enable completely new products for renewable energy systems. We must build a strong network of industrial and academic partners in order to succeed.

So far, **KM2** consists of a number of precursor projects. The new HÖG project **Paper Solar Cell** is one of these. Funding has also been granted by Energy Agency to projects that focus on supercapasitors (**KEPS** and **Modulit**), and by the Regional Development Fund (Mål2) to the development of the coating process (**COAT**). We are also well positioned to gain leadership in a new Strategic Innovation Research and Area **New Bio-based Materials, Products and Services**. The application led by Forest Industries Federation has been submitted to Vinnova for funding. Supported by the ARC13 review, we believe that **KM2** will give us national leadership and international visibility in a "hot" research area. Hence we expect a strong contribution also to *TIE 2 Leading* and *TIE 5 International*.

2.2. Goal 2: Increased synergies and stronger competences of FSCN and STC

In addition to the work towards a strong and sharp research profile we also have other areas where synergies between FSCN and STC can be increased and the competences of each centre improved. In the 3-year *Goal 2* we defined four of such development areas, *Augmented Functionality*, *Improved Efficiency*, *Renewable Energy Systems*, and *Pure Environment*. However, we then realized that these areas do not give us sharp enough focus. Therefore we have in the Work Plan 2014-2016 instead two specific Strategic Actions that support *Goal 2*, **FORIC** and **FLEX**.

The Industrial Graduate School **FORIC** is in the starting phase. This is a joint action of FSCN and STC and thus efficiently increases the synergy between FSCN and STC. It relies on exceptionally strong resources as most of the research groups in the KK Research Environment, and some outside, are involved (See Appendix C). The aim of **FORIC** is to support the development of a symbiotic industrial network of companies and an ecosystem for open innovations (cf. *TIE3 Start-ups*). It builds on the research made in the large regionally-funded program **FORE** that is now ending. **FORE** consisted of a number of research directions bound together by the use of forest-based raw materials. The new Strategic Initiative **FORIC** focuses more than **FORE** on the *Industrial Transformation* of the TIE Vision. **FORIC** collaborates with the Vinnväxt initiative **Bio-Business Arena**, and we are together exploring alternatives to establish a regional development program on bio-economy with the new EU Structural Funding program (Mål2).

The project **FLEX** is a combined initiative of STC and FSCN to develop the courses and methods needed to implement a Master-by-Research program where the students can work in industry just like industrial PhD students. The focus in **FLEX** is in the IT-enabled pedagogical methods enabling the students to benefit from both the industrial development environment and the academic research environment. Thus **FLEX** is important for *Goal 3 Improved co-production* and *TIE 4 Education*.

The synergies between FSCN and STC also increase in the Strategic Action **KM2** that connects the two centres through research on electronic materials and functionalities. The synergistic impacts of **FORIC** and **KM2** are clearly visible in Appendix C.

The respective strengths of FSCN and STC are naturally also supported by **e2mp** and **EnergyWiser**. **E2mp** develops and exploits FSCNs leading position in mechanical pulping. **EnergyWiser** builds us a nationally leading position in embedded sensors.

Finally, we recognize three competence areas that have clear industrial relevance but we have not yet identified a clear focus. Therefore we also lack power in the research content and industrial networks. More work is needed to before we know if these areas can grow into Strategic Initiatives:

- "New Cellulosic Materials" (tentative name) where we should combine our expertise at least in High-yield pulping, Surface and colloid engineering and Complex systems. This could later become the second focus area that is called for in the 3-year *Goal 1* under the heading **Advanced Paper Materials**. Aside from paper companies, also other industrial partners are needed, e.g. converters who would deliver the substrate for the solar cells developed in **KM2**. Other materials, e.g. textiles are targeted in the Strategic Innovation Research and Area **New Bio-based Materials, Products and Services.**
- "Measurement technology" where our industrial partners see growth opportunities especially in environmental surveillance and in process control that can result in higher resource efficiency. When the development of functional surfaces in **KM2** moves to pilot phase, the quality assessment of coated surface layers requires new methods.
- "Industrial communication systems" with focus on the use and aggregation of measurement data in process control. This is expected to lead to an Industrial Transformation where process control and measurement becomes an externally supplied service business.

2.3. Goal 3: Quality of co-production

Collaboration in research projects constitutes the main body of industrial co-production. The data on this is in Sections 3 and 4 of Appendix B. Looking at industrial partners that are currently involved in our research projects, one can see that the number of non-SME companies has decreased from 41 in 2011 to 34 in 2013. The number of involved SMEs has remained constant at 45-46 companies. Last year we had in total 89 non-academic partners, down from 97 in 2011. However, the volume of research collaboration did not change, if measured by the number of scientific publications together with non-academic partners. This has have been roughly constant the last three years at 21-24 papers per annum. Purely academic collaborations have decreased from 34 to 24 papers in the same period.

The list of partner companies in Appendix B list includes all companies that are currently involved in our projects, many of them in part or completely through projects that have other than KK funding. The actively engaged partners change with the projects. For example, we acquired 14 new partner companies in 2013. FSCN engaged two new kind of industrial partners through **KM2** project **KEPS** (Superior Graphite and STT Emtec). Several other similar partners are involved in **Paper Solar Cells** that is now starting. Other new companies will arrive when the consortium of **FORIC** is ready. All these companies extend FSCNs industrial network beyond the forest-based sector that we traditionally work with. STC has new partner companies related to **EnergyWiser** (SMHI, SAAB AB, Termisk Systemteknik, SWECO Energy), and other new partners in projects targeting environmental sensing (MittSverige Vatten, Cogra, Ångström Laboratoriet).

The competence development for industry is an important part of co-production. The Strategic Initiatives **FLEX** and **FORIC** improve the support we can give to industrial Master and PhD students. **FORIC** directly answers to one of the 3-year targets: Goal 3 *Offer industrial PhD students a coherent study environment*. We have also set as a goal to recruit adjunct professors in the areas of green products, processes and intelligent services. The number of adjunct professors has gradually increased from 6 in 2011 to 10 in 2013. The list of adjunct professors and their area are given in Section 5 of Appendix B.

Co-production with industry involves not only the collaboration during research projects but also various forms of interaction that contribute to the planning and steering of our research. Here the main improvement is the establishment of a Reference Group of the KK Research Environment. In the area of mechanical pulping most of the research is planned together with companies, as the research concerns existing process equipment. In the other end of the spectrum, **KM2** develops new process equipment, and therefore requires industrial collaboration on the level of strategic business and technology development.

3. KK Research Actions

The KK Research Actions continued in 2013 by and large according to plans. The Strategic Actions **e2mp** and **FLEX** progress according to plans. **FORIC** is in the starting phase, and **EnergyWiser** and **KM2** under preparation. The only larger deviation occurred in the one-year Prospect **Ink-media interaction** where the industrial participation remained smaller than planned because of problems with agreements. MIUN covered the difference with own funds.

Considering the strategic impacts, several of the projects contributed in different to *Goal 3: Quality of co-production* (**ORESS, COINS, Robust, Low-energy CTMP, Paper Solar Cells**) in addition to the major impacts made on co-production by all the Strategic Initiatives. Two of the projects, **ORESS** and **Syspack** produced especially important technical results. The coating process invented in **Syspack** was central to the creation of the Strategic Initiative **KM2**. **Syspack** was also exceptionally productive scientifically. In **Modifiering av flisningsprocessen** a paper in a notably high-impact journal (Holtzforschung) was published (cf. the goal to *Increase the proportion of publications in high-quality journals* under *Goal 1*).

The main results are of the projects are explained in Chapter 3.1. An executive summary for each current KK Research Action is in Appendix D, and the economic report in Appendix E.

The motivations for new project proposals are explained in Chapter 3.2. The preliminary portfolio of KK Research Actions 2015-2017 is in Appendix F. In the planning of new projects for 2015 we have especially requested the researchers to prepare proposals that support our Strategic Initiatives. This worked quite well, out of the 15 proposals that are left, 9 are related to the Strategic Actions and thus support *Goal 1: Stronger research profile and higher quality*. Most of them also directly develop new products, in line with the TIE Vision of *Industrial Transformation*.

3.1. Results achieved in 2013

We analyse the results of the KK Research Actions in 2013 according to their impact on the 3-year goals.

Goal 1 Stronger research profile and higher quality

The KK Profile+ **STC Industrial IT** that ended in 2013 made a large impact on the development of the MIUN KK Research Environment. Aside from large academic production (132 articles, 7 PhDs and 10 licentiates) it determined the direction of our research on industrial IT. In the Strategic Initiative **EnergyWiser** we thus focus on embedded distributed sensing as applied to improved efficiency in energy production and consumption. The research plan includes the competences on Sensor networks; Wireless measurement systems and High-performance embedded computing that were developed in **STC Industrial IT.** A new research area of Wireless Energy Transmission is also needed in **EnergyWiser**. The detector technology and printed electronics developed in **STC Industrial IT** are important parts in the Strategic Initiative **KM2**. The remaining competences from **STC Industrial IT** need to be developed further (See Measurement Technology and Industrial Communication Systems in Chapter 2.2).

In our Project Portfolio we have also (had) three precursor projects to **EnergyWiser**: **ORESS** that ended 2013, **COINS** that ends 2014, and **Robust** that started 2013. In **ORESS** we developed and demonstrated on-rotor sensing technology that shows the impressive opportunities of embedded sensing, such as accurate and cost-effective measurement of fundamental properties, and new actuator structures for energy-efficient motors etc. New challenges also emerge for wireless energy transfer. **COINS** has characterized industrial communication environments and built methods to cope with them with robust wireless communication protocols. This knowledge will be important in the network part of **EnergyWiser**. In the project **Robust** we have built a strong national and international co-production team that is part of the **EnergyWiser** initiative. Also the other two projects have been important in the development of broad co-production (*Goal 3 Quality of co-production*).

The project **Syspack** that ended last year played strategically important role as a precursor to Strategic Action **KM2**. In **Syspack** we demonstrated in laboratory scale a method for coating paper with thin layers of self-organized functional layers. This open up the way to preparation of solar cells, supercapasitors etc. with a high-speed coating process, a crucial requirement for low-cost products. The formation of the functional layers was modelled at particle level. The patterning of aluminium layers and printing of conductive multilayers were demonstrated, as well as the surface mounting of electronic devices. The project was also very productive, 32 publications and 5 demonstrations.

The Strategic Action (Research Profile) **e2mp** continues to 2016. The half-time review is in progress. Two of the **e2mp**-projects have already reached their objectives. **BAT-2012** will be finished in March 2014. It has given much valuable input to the companies running the 16 benchmarked TMP- and CTMP-lines. The **e2mp**-project **Chip-pretreatment/DD-refining** has reached the goal of 15% improvement in energy efficiency. The other **e2mp**-projects started with more fundamental approach and laboratory-scale studies. In the second 3-year period we will start a new CTMP project in the Research Profile (depending on Board approval), and another on control-based process design. With these additions, the project portfolio of **e2mp** will match the original plan. We are confident that the Research Profile will reach the goal of showing how electric energy consumption can be reduced by 50% without changing important fibre properties.

The complementary project **Modifiering av flisningsprocessen** will be concluded later this year in accordance with the updated project plan. In the project we have used theoretical modelling to derive a relevant damage parameter. The result was then used to reduce energy consumption in an industrial mechanical pulping process. At another partner company, the project has led to a new product (new type of a chipping knife). One paper in a high-impact journal has been published.

A second complementary project to **e2mp** was **Low-energy CTMP** that was finished in 2013. In this project we demonstrated in industrial conditions that board strength can be significantly improved by a multilayer treatment of fibres that we developed. High-temperature CTMP of birch was produced in an industrial process at only 600 kWh/t energy consumption. The strength increase by press-drying was studied in laboratory conditions. The project was extended by 6 months from the original plan. An extra pilot trial was run at Innventia and more effort was put on press-drying. Both changes were strongly supported by the industrial partners. They as well as the external reviewer considered the project very successful. Co-production in this project has been exemplary for *Goal 3 Quality of co-production*. A follow-up project is discussed in Chapter 3.2.

Goal 2 Increased synergies and stronger competences of FSCN and STC

In the Strategic Initiative **FLEX** the initial development of IT-supported pedagogical methods for remote Master-by-Research studies is ready. The development of common courses between STC and FSCN has started. These courses will increase education quality also in **FORIC**.

Two projects that ended last year developed specific competences at STC or FSCN. In **Faskontrast**, we developed methods for the characterization of materials on a surface using energy- and phase-resolved X-ray imaging. These methods can be used to characterize commercially-used coating materials for improved visual perception of printed products and may enable on-line characterization during production. Potential applications exist also in functional surfaces and thus especially **KM2**. In the prospect **Ink-media interaction** the collaboration agreement with companies required much time and in the end the industrial contribution was smaller than originally planned. MIUN covered the difference so that the project could be completed as planned. The focus was on the fundamentals of ink setting. Nano-scale measurements were made on the mechanism of colour locking in paper. The strategic motivation behind the project was to develop competence with bearing on the printing of electronic functionality on paper. However, the findings in **Syspack** proved more promising and therefore we decided to discontinue the research line of **Ink-media interaction**.

The prospect **PlenoCap** that started last year has set up experimental equipment to evaluate the technology that will be developed. This project is part of the competence development on Measurement Technologies.

3.2. New KK Research Actions starting or under planning

In the planning of new projects for 2015 we have especially requested the researchers to prepare proposals that support our Strategic Initiatives **EnergyWiser** and **KM2**, as well as the on-going Strategic Action **e2mp**. For **EnergyWiser**, we need more research on the Industrial Communication Systems. The specific research plan of **KM2** is building on the existing and new projects. In connection to **e2mp** we wanted to further strengthen the input from STCs competences on Embedded Sensors and Measurement Technology. The need for better measurements was also clear from the results of **Filling the Gap**, a large Vinnova-funded project that ended in 2013.

Aside from strengthening the Strategic Initiatives, we have recognized that as the **KM2** initiative focuses on electronic materials. We therefore will need another “leg” to the original initiative **Advanced Paper Materials / Large Functional Surfaces** with focus on the paper substrate and other cellulosic materials. In that way we can utilize FSCNs strong position in mechanical pulping and fibre science, and also more directly support the renewal of paper industry. For this purpose we want to explore and test a number of pathways through on-going projects and new project proposals. The strengthening of STCs Measurement Technology is also important. For example, growing market is foreseen in the area of environmental sensors.

The motivations for the planned new KK Research Actions are as follows. The preliminary portfolio KK Research Actions 2015-2017 is in D.

Goal 1 Stronger research profile and higher quality

For the Strategic Initiative **EnergyWiser** we plan two complementary HÖG projects **NextPReWIC** and **M2M_COMS**. The first project will develop technology wireless real-time communication for industrial applications where reliability and predictability are important. The second project will investigate scalable technology for smart grid communication. This will be a vital part in the control of future renewable energy production since the distributed production must dynamically respond to changes in consumption.

An important spin-off project from the technology knowledge and coproduction that has led to **EnergyWiser** and that has a potential to become very important is the project **OREAS** Motor. In this project the technology base in **EnergyWiser** is used to develop technology that result in a new type of electrical motor that show a potential to be more efficient than the state of the art motors. This means that that the project has a potential to substantially decrease the energy loss in industrial and other electrical motors, where electrical motors consume half of the total electrical energy consumption in the world.

We also have two projects that support both **EnergyWiser** and **KM2**: the project **Medium power isolated converters** is starting and the prospect **Gridless** is under planning. They are both part of the new research area of Wireless Energy Transmission which is important part of **EnergyWiser**. The first project will build knowledge on power conversion. The second project develops technology for harvesting and storing electrical energy in systems that are not connected to fixed power lines. This is important in reducing the maintenance cost of wireless sensors. For **KM2** these projects offer the connection to the future industrial users of the technology developed in **KM2** (in line with *Goal 3: Quality of co-production*).

Two HÖG projects and one planned HÖG Synergy are currently the KK-funded part of **KM2**. The HÖG projects that are starting are **Paper Solar Cells** and **ID-Pos**. The first one works on a broad front on the manufacturing aspects of the solar cell material. The second one investigates technology for connecting functional surfaces to physical objects by detecting radio signals transmitted over the surfaces. The research plan and technology road map of **KM2** will be compiled in the proposed HÖG Synergy Action **KM2**. Also the other projects than those funded by KK Foundation will naturally be included. Two Prospects and one HÖG are proposed to be included in the HÖG Synergy Action. In the Prospect **FILM** the goal is that the researcher will build research on a novel method to prepare metallic conductors on paper. Such conductors are needed in the applications. The organic conductors currently available for flexible surfaces have the problem of low conductivity. In the second Prospect **Surface Engineering** the focus is on the exfoliation of molybdenum disulphide and graphene and the coating of paper with them. These two materials are the key electronic materials in the products we are working on. The HÖG Project **ELGEN** will explore the feasibility of large-area conversion of surplus heat of industrial processes directly into electricity.

Goal 2 Increased synergies and stronger competences of FSCN and STC

Following new or planned KK Research Actions are increasing the synergy of FSCN and STC.

- The Strategic Actions **FORIC** and **FLEX** are in the starting phase. They are also motivated by *Goal 3: Quality of co-production*.
- In relation to the Strategic Action **e2mp**, we have two projects that aim at increasing the use of STCs measurement technology in mechanical pulping research. The complementary project **Wood chipping** is now in the starting phase. It will use measurements for better steering of the chipping process. The project in planning is **XFIBER**, which investigates how X-ray technology can be used to better understand the defibrillation process through X-ray microscopy of cellulose fibres and fibrils.
- In the planned project **SURF** we will investigate the combined on-line characterization of surface topography and coating material distribution, which is relevant for today's paper products and later will be important for **KM2**. The organizational target of this initiative is to consolidate research done by STCs research group Visual Sensor Systems and FSCNs Digital Printing Centre.

FSCNs competence area of "New Cellulosic Materials" (tentative name) is supported by of four new or planned precursor projects. The long-term goal is to secure the use of our mechanical pulping competence in the development of new products, including those studied in **KM2**.

- We are starting the project **Reliability** that aims to find out how to improve the long-term strength of materials based on wood fibres.
- A new HÖG project **HardHYPack** is planned to continue research on the use of birch CTMP in food packaging. The removal of extractives is a critical requirement in such applications. In the previous project we demonstrated how multilayer treatment of fibres can give superior strength properties for the board. We believe that the technology can enable the use of CTMP also in future paper materials, and therefore want to continue competence development. This research line is also an excellent example of co-production and we want to maintain the good relation with the industrial partners (cf. *Goal 3*).
- Another very important new action in planning is the recruitment of Dr. Björn Lindman from Univ. Coimbra as a Guest professor in **GP Bio** in order to develop our research. Professor Lindman has laid the foundation for a new way to dissolve cellulose. We see very interesting possibilities to apply that approach on mechanical pulps.
- The second exploration of new research path is the HÖG proposal on **Fibre Microfluidics**. The goal is to understand what happens when bio-fluids move through a fibre network. Control of the fibre-level transport process is central in the development hygiene products, but also in many other areas such as geotextiles. Broadening FSCNs industrial network is an important motivation for this project.

In STCs competence area of Measurement technology we have three projects that can form a coherent Strategic Initiative and also increase synergy between STC and FSCN. The key question we need to solve is the primary application area of the measurement technology. Two of the planned projects, **XFIBER** and **SURF**, are described above The planned project **OMG Character** builds new competence in making wood harvesting more efficient with 3D capturing technology, and can support the strategic action **FORIC**.

Appendices

Appendix A: Long term strategic goals

Appendix B: Indicators

Appendix C: Research groups

Appendix D: Reports of KK Research Actions 2013

Appendix E: Economic report of KK Actions

Appendix F: Preliminary Portfolio of KK Research Actions 2015-2017

Appendix A – Long term strategic goals

Long-term strategic goals (TIE)

The 10-year goals of the TIE Vision are summarized in the following table. For clarity, a short title has been added to each of the five goals.

Long term goal – 10 years perspective	**Strategic funding partner**
TIE1 Resources: The environment has attracted the research competence needed to stand strong as an attractive research institution in the selected profile area. (organisational)	Strategic recruitment, Prospect (KKS), Mobility (EU), Postdoc (Sundsvalls kommun), Län, Tillväxtverket
TIE2 Leading: The environment is regarded as one of the leading research and innovation locations in the targeted area. The research has a strong influence in the research community as well as in important industrial networks. Large visibility at the most important conferences, well recognized publications and established contacts to the most important competence environments. (scientific)	Vinnova, VR, SSF, Tillväxtverket, Sundsvalls kommun, Industrial research grants (national and international), KKS (HÖG/Profil), EU
TIE3 Start-ups: The environment attracts business angels and venture capital investing in new ventures from our research and education. (collaboration and innovation)	Innovationsbron, Vinnova, Business angels and venture capital, industrial contracts
TIE4 Education: The education programs related to the environment is attractive and young students compete to take part in the development. Well established master by research education in collaboration with leading industrial networks attracts good international students from all over the world. (organisational and collaborative)	Partner industries and industrial networks, partner universities (ex KTH, SU)
TIE5 International: The environment attracts international collaboration and exchange programs with leading academic institutions and leading industry. The environment takes part in shaping the future research agenda for both national and international research programs. (scientific and collaborative)	EU Horizon 2020, Vinnova, STINT,-EU Interreg

Appendix B – Indicators

1. Research staff involved in the KK-environment
(Number of individuals and full-time equivalents)

Table 1.1.1 Doctoral students

Year	**2011**		**2012**		**2013**	
Gender	**M**	**W**	**M**	**W**	**M**	**W**
PhD students	39	18	46	17	46	14
FTE*	30,72	11,85	35,34	12,22	33,74	12,81

Table 1.1.2. Post docs and research assistants

Year	**2011**		**2012**		**2013**	
Gender	**M**	**W**	**M**	**W**	**M**	**W**
Post docs	0	0	0	0	0	0
FTE						
Research Assistants	2	3	2	2	3	1
FTE	1,96	1,29	1,89	0,77	2,41	0,92

Table 1.1.3. Assistant professors, associate professors and professors

Year	**2011**		**2012**		**2013**	
Gender	**M**	**W**	**M**	**W**	**M**	**W**
Assistent professors	23	5	22	6	26	7
FTE	15,02	3,87	12,18	5,07	17,81	5,86
Associate professors	4	0	5	0	4	0
FTE	2,91	0	3,66	0	2,8	0
Professor, permanent	22	1	22	1	20	1
FTE	15,15	0,5	14,72	0,5	13,72	0,48
Professor, adjunct	7	0	9	0	10	0
FTE	0,8	0	1,2	0	1,2	0
Professor, guest	2	0	2	0	3	0
FTE	1,35	0	0,55	0	1,2	0

* Full Time Equivalent

** Professor denotes persons employed as full professors. Associate professor denotes staff qualified to act as principal advisor for PhD students (docent appointment or similar). Assistant professors denote the rest of staff with a PhD.

Table 1.1.4. Other researchers

Year	2011		2012		2013	
Gender	**M**	**W**	**M**	**W**	**M**	**W**
Other researchers***	8	0	8	1	7	2
FTE	4,2	0	5,35	0,5	4,24	0,83

*** Denotes researches without PhD

2. Result of the KK-environment (research and education at advanced level)

Table 2.1 Number of doctoral-, licentiate- and master degrees

Year	**2011**		**2012**		**2013**	
Gender	M	W	M	W	M	W
No. Doctoral degrees	4	0	0	3	12	4
Proceeded to external position	4	0	0	2	9	4
No. Licentiate degrees	12	4	14	0	6	4
Proceeded to external position	0	1	1	0	0	2
No. Masters degree	31	2	38	8	36	11

Table 2.2 Number of scientific publications

Year	**2011**	**2012**	**2013**
Article in Journals	75	90	58
Conference Article	67	63	69

Table 2.3 Recently appointed promotions

Year	**2011**		**2012**		**2013**	
Gender	M	W	M	W	M	W
No. Docent promotions	2	0	2	0	0	1
No. Professor promotions	1	0	1	0	0	0

Table 2.4.1 Funding (money spent in SEK)

Financier	2011	2012	2013
Faculty funding (MIUN)	45 462 605	41 579 928	38 588 205
Research Councils (VR, FAS, Formas etc.)	573 597	791 297	1 306 617
Swedish Foundations (e.g. Wallenberg, SSF, Vinnova, RJ, KK, Swedish Energy Agency etc.)	22 457 174	31 822 870	35 232 562
EU	28 349 654	29 243 560	19 761 799
Direct funding from non industrial organizations in society	6 583 051	6 471 125	5 410 759
Direct external funding from industry	2 911 831	3 253 335	2 832 731
Others (Bo Rydins stiftelse, Kempestiftelserna)	7 382 196	6 163 683	5 248 816
Indirect funding from non industrial organizations in society (in kind*)	0	735 498	495 246
Indirect external funding from industry (in kind*)	20 976 301	26 664 867	34 905 768
Total Funding	134 696 409	146 726 163	143 782 503

*value of working hours done by external partners, value of equipment, databases, software, laboratories etc. that external partners provide in joint research projects.

Table 2.4.2 External Funding (applied, approved)

Finansiärer	2013		
	applied	approved	success rate*
Research Councils (VR, FAS, Formas etc.)	59 651 000	200 000	8%
Swedish Foundations (e.g. Wallenberg, SSF, Vinnova, RJ, KK, Swedish Energy Agency etc.)	97 716 819	38 365 168	41%
EU	15 573 000	5 286 500	20%
Direct funding from non industrial organizations in socitety	16 230 000	3 530 000	22%
Direct external funding from industry	2 400 000	2 400 000	100%

* ratio of approved and applied funding

3. Coproduction

Table 3.1 External funding (money spent in SEK)

Year	2011	2012	2013
Direct external funding from industry	2 911 831	3 253 335	2 832 731
Indirect funding from industry (in kind*)	20 976 301	26 664 867	34 905 768

*value of working hours done by external partners, value of equipment, databases, software, laboratories etc. that external partners provide in joint research projects.

Table 3.2 Collaborative Organizations

Year	2011	2012	2013
No. of partners from industry (SME)**	46	46	45
No. of partners from industry (non SME)	41	41	34
No. of partners from society excl. industry and academia	10	10	10

**Enterprise with no more than 250 employees and an annual turnover not exceeding 50M €

Table 3.2.b Collaborative Organizations, their contribution to and their relevance for the KK-environment

Year				2011	2012	2013
Company name	**Company type**	**Company's major contributions to co-production**	**Grade*** **	[yes = x]****	[yes = x]	[yes = x]
Aalborg University, Denmark	Institution	Research cooperation	2			x
Aalto University, Helsinki, Finland	Institution	Research cooperation	2	x	x	x
ABB	non SME	Multi competence against embedded sensors	3	x	x	x
Acreo	Not ind./acad.	Multi compence against STC, Laboratory facilities, expertise	3	x	x	x
Acreo Swedish Ict AB	SME	Full STC competence spectra	3	x	x	x
Akzo Nobel Pulp and Performance Chemicals (Eka)	non SME	Expertise, materials	2	x	x	x
Andritz	non SME	Expertise	2	x	x	x
Andritz Iggesund Tools	SME	End user and developer of measurement systems, Manufacturing equipment, expertise	2	x	x	x
BAE Systems AB	non SME	Multiple competences, e.g. power converters and hybrid technology	2	x	x	x
Beijing Jiatong University	Institution	Research and education cooperation	3	x	x	x

Beijing University of Technology,	Institution	Research and education cooperation	3	x	x	
BinZero (Anders Karlström)	SME	Expertise	2			x
Cargotech (Hudiksvall)	SME	Development and end user of industrial measurement system		x		
Center for Medical Image Science and Visualization (CMIV), Linköping,	Institution	Research cooperation	2	x	x	
CERN.	Not ind./acad.	Network and demans for radiation detectors	3	x	x	x
Chalmers Industriteknik	Institution	Laboratory facilities, expertise	2	x	x	x
Cobolt AB	SME	Laser technology competence	2	x	x	x
Cogra pro AB (via samarbetet med RTI)	SME	Electroic system production competence	1			x
Collectric	SME	Competence in technoology for energy control systems and embedded sensor systems		x		
Combitech AB	non SME	Multiple competences, e.g. visual measurement systems	3	x	x	x
Cree	non SME	Power component competence	3	x	x	x
Cross Control AB	SME	Competence in embedded systems development and production	2	x	x	x
CSIRO (Australien)	Not ind./acad.	Research cooperation	2	x	x	x
DACC Systems	SME	Competence in security systems and as end user of sensor services	2	x	x	x
Dametric	SME	Measurement equipment, expertise	2	x	x	x
DESY, Germany, Synchrotron (adj. Prof.)	Institution	Research cooperation	3	x	x	x
DeWire	SME	Competence in communication systems and system development	2	x	x	x
DIAMOND Light Source, England	Institution	Research cooperation	2	x	x	x
Donghua University	Institution	Research cooperation	2	x	x	
Elforest AB	SME	Hybride technology competence	2	x	x	x
Ericsson	non SME	Competence in communication systems and 3D video end user	2	x	x	x
ESRF, France	Institution	Research cooperation	2	x	x	x
ESS, Lund	Institution	Scientific recuirements and competens on neutron detectors	3	x	x	x
ETAL group AB	SME	Electronic system competence	2	x	x	x
Fiber Optic Valley AB,	Not ind./acad.	Innovation cluster node	3	x	x	x

Flint Group	non SME	Expertise, materials	1		x	x
Fotonic AB	SME	Real time vision competence	2	x	x	
Glasgow University,	Institution	Research cooperation	2	x	x	x
Greenwich University	Institution	Research cooperation	2	x	x	
Gunnebo Nordic AB	SME	End user competence in RFID	1	x	x	x
Holmen	non SME	Manufacturing facilities, expertise, materials	3	x	x	x
Hybricon	SME	Hybride technology competence	1		x	x
Hägglund Drives AB	non SME	Development and end user of industrial measurement system	3	x	x	x
IBERobot AB	SME	End user competence in power conversion systems	2	x	x	x
IEAP, Czech Technical University in Prague	Institution	Research cooperation	3	x	x	x
Iggesund Paper Board	non SME	Process control and measurement system end user competence	3	x	x	x
Ikonoskop AB,	SME	Camera technology competence	2	x	x	x
Inmec Network Technologies	SME	End user competence in power conversion systems	2	x	x	x
Innventia	Institute	Pilot facilities, expertise	2	x	x	x
Inovocell (Ola Johansson)	SME	Expertise	1			x
IPHT, Jena, Germany	Institution	Research cooperation	2	x	x	x
KTH	Institution	Research cooperation, Laboratory facilities, expertise	2	x	x	x
Laser Nova AB	SME	Laser technology competence	2	x	x	x
Laser physics group, KTH, Albanova, Stockholm	Institution	Research cooperation	2	x	x	x
Lasercut AB	SME	Laser technology competence	1	x	x	x
Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA	Institution	Research cooperation	2	x	x	x
LC Tec AB	SME	Competence in display technology	2			x
Leine & Linde	SME	Development and end user of industrial measurement system	2	x	x	x
Linköping University	Institution	Laboratory facilities, expertise	2			x
Länssjukhuset i Sundsvall-Härnösand,	Not ind./acad.	Medical imaging competence	1	x	x	x
Mantex AB	SME	X-ray based measurment competence	3	x	x	x
MAXLAB, Lund	Institution	Research cooperation		x	x	x

Mecsense AS	SME	Measurement system and sensor competence	2		x	x
Meeq AB	SME	Competence in visual sensor systems		x	x	
Metso Paper/Valmet	non SME	Manufacturing facilities, expertise	3	x	x	x
Metsä Board	non SME	Manufacturing facilities, materials	2	x	x	x
Micro- och Nanosystem group, KTH, Stockholm	Institution	Research cooperation	2	x	x	x
MittSverige Vatten AB	non SME	End user competnece in sensor services	1			x
MoRe Research	SME	Pilot facilities, expertise	2	x	x	x
Mälardalens Högskola	Institution	Research cooperation	2			x
NetCorner Europe AB,	SME	End user of visualization systems	2	x	x	
Nordic Fast Food AB,	SME	End user of visualization systems	2	x	x	
Nordic Paper	non SME	Manufacturing facilities, materials	2			x
Norske Skog	non SME	Manufacturing facilities, expertise, materials	3	x	x	x
NTNU/HiST, Trondheim, Norge	Institution	Research and education cooperation	3	x	x	x
OCE Printing Systems	non SME	Expertise, manufacturing facilities		x	x	x
OnTop Measurement AB	SME	Spin-off from STC in printed detectors	3		x	x
Optoskand AB	SME	Laser technology competence	2	x		
Optronic AB,	SME	Optical measurement system competence	2	x	x	x
Oregon Scientific AB	SME	Environmental monotoring system competence	2	x	x	x
PEAB AB	non SME	Measurement system end user competence	1	x	x	x
Permobil AB	SME	Measurement system end user competence	2	x	x	x
PFI - Paper and Fibre Research Institute	Institute	Laboratory facilities, expertise	3	x	x	x
Politecnico di Torino, Turin, Italy	Institution	Research cooperation	2	x	x	x
PrintDreams Ltd	SME	Competence in visual sensor systems		x	x	
Proximion AB	non SME	Optical fibre competence	2	x	x	x
PulpEye AB	SME	Development of industrial measurement system and visual sensor system	3	x	x	x
Pöyry	non SME	Expertise	1	x	x	
QualTech (Jan Hill)	SME	Expertise	1			
Riksarkivet/MKC	Not ind./acad.	End user of visual sensor system competence	1	x	x	x
RTI Electronics	SME	Radiation detector and detector application competence	3	x	x	x

SAAB	non SME	Multi site cooperation on measurement systems, noise handling and power conversion	3	x	x	x
SCA Forest Products AB, Östrand, Ortviken	non SME	Process control and measurement system end user competence, Manufacturing facilities, expertise, materials	3	x	x	x
SCA R&D AB	non SME	End user competence in measurement systems and large functiona surfaces	3	x	x	x
SCINT-X AB	SME	X-ray detector technolgy competence	3	x	x	x
SenseAir AB	SME	Detector and environmental sensor competence	3	x	x	x
Sensible Solutions Sweden AB	SME	Spin-off from STC in printed detectors	3	x	x	x
Sensient Imaging Technology	non SME	Laboratory facilities, expertise	1		x	x
SEPS Technologies AB	SME	Spin-off from STC in power converters	3	x	x	x
Servanet	non SME	Competence in communication systems	2	x	x	x
Setred AB, Stockholm ,	SME	3D display competence	2	x	x	x
Shortlink	SME	Compentence in embedded communication and embedded sensors	3	x	x	x
SICS	non SME	Laboratory facilities, expertise	1			x
Simicon AS, Norge	SME	Drone, robotics and measurement system competence	2			x
Sintef, Oslo, Norway	Institution	Research cooperation	2	x	x	x
Sitek Electro optics	SME	Detectorand detector application competence	2	x	x	x
SLU	Institution	Laboratory facilities, expertise	1	x	x	x
SMHI	Not ind./acad.	Environmental monotoring system competence	2			x
St. Gobain Abrasives	non SME	Measurement equipment, expertise	1	x	x	x
Statkraft Vind Sverige	non SME	End user compentece in visual sensor systems	2	x	x	x
Stiftelsen Adopticum	Not ind./acad.	Competence in optical measurement	2			x
Stora Enso	non SME	Manufacturing facilities, expertise, materials	3	x	x	x
STT Emtec	SME	Expertise, end-user of our new material	2			x
Sundsvalls Kommun	Not ind./acad.	Research support and end user of sensor services	3	x	x	x
Superior Graphite	non SME	Expertise, materials	2			x
Sweco Energy AB	Not ind./acad.	Multi competence cooperation	2			x

Swedish Connection	SME	Competence in communication systems and end user in sensor based services	2	x	x	x
Svelander Holding AB	SME	End user of visual sensor system competence	1			x
SweProd Graphics AB	SME	Advanced printing technology competence	2	x	x	x
Termisk Systemteknik AB	SME	Optical measurement system competence	2			x
The MEDIPIX collaboration	Not ind./acad.	Network.	3	x	x	x
Timrå Elbyggnad AB	SME	End user competence in power conversion systems	2	x	x	x
University of Applied Sciences Osnabrück, Tyskland	Institution	Research and education cooperation	3	x	x	x
University of Brunswick, Canada	Institution	Research cooperation	2			x
University of Edinburough	Institution	Research cooperation	2	x	x	x
University of Hamburg, Hamburg, Germany,	Institution	Research cooperation	2	x	x	x
University of Valencia, Spain	Institution	Research cooperation		x	x	x
Uppsala Universitet	Institution	Research cooperation	2			x
Webshape AB	SME	Competence materials and technology for large functional surfaces	3	x	x	x
VisualEyes AB	SME	End user compentece in visual sensor systems	1	x	x	x
ÅF- Ångpanneföreningen	non SME	Expertise	1	x	x	x
Åkroken Science Park	Not ind./acad.	Innovation cluster node	3	x	x	x
Ångströmlaboratoriet Uppsala univ.	Institution	Research cooperation	2			x

Table 3.3 New Collaborative Organizations

Year	**2011**	**2012**	**2013**
No. of new partners from industry (SME)**	7	2	10
No. of new partners from industry (non SME)	7	2	4
No. of new partners from society excl. industry and academia	0	1	1

**Enterprise with no more than 250 employees and an annual turnover not exceeding 50M €

4. Mobility between academy and society

Table 4.1 Mobility between academia and society

Year	2011	2012	2013
No. of collaborative doctoral students*	11	12	10
No. of researchers with temporary positions outside university**	2	0	1
No. of adjunct researchers	6	8	9

*Doctoral students in the UoA who are financed by non-academic external partners. Note that this does not mean doctoral students who are financed by any non-academic funding body, but students who are financed by external partners of the UoA (e.g. industry or public sector organizations).
** Permanent university staff who are temporarily employed in non-academic society

5. Co-production

Table 5.1 Number of scientific publications with representatives from outside the university

Year	2011	2012	2013
No. of scientific publications with representatives from society (not academia)	21	24	23
No. of scientific publications with representatives from academia	34	32	24
No. of scientific publications with representatives from both academia and society	5	10	16

*Doctoral students in the UoA who are financed by non-academic external partners. Note that this does not mean doctoral students who are financed by any non-academic funding body, but students who are financed by external partners of the UoA (e.g. industry or public sector organizations).
** Permanent university staff who are temporarily employed in non-academic society

Table 5.2 Adjunct professors with employment outside the university

Name	Company
Focus on green products and processes	
Folke Österberg	SCA R & D Centre AB
Lennart Salmén	Innventia AB
Magnus Paulsson	Akzo Nobel Pulp and Performance Chemicals
Thomas Granfeldt	Valmet AB
Focus on intelligent services	
Mikael Gidlund	ABB
Focus on embeded services	
Heinz Graafsma	Desy AB
Jan Andersson	Acreo AB
Richard Hall-Wilton	ESS AB
Kjell Brunnström	Acreo AB
Lars Norin	Acreo AB

Appendix C – Research groups

Research groups

The following table lists all the research groups that through the two research centres STC and FSCN belong to the KK Research Environment, and all the projects they are involved in. New KK project proposals are shown in red. We show the role of the groups in the Strategic Actions and their engagement in other projects that are related to the Strategic Action (using project acronyms). Other projects are justified through the development of competence that we believe is important for the applications shown.

		STRATEGIC ACTIONS				COMPETENCE DEVELOPMENT			
RESEARCH GROUP	**GROUP LEADER**	**e2mp (-rp & -i)**	**FORIC**	**EnergyWiser**	**KM2**	**Measurement technology**	**Industrial Communication Systems**	**Advanced Cellulosic materials**	**Other**
High-Yield Pulping	**Per Engstrand**	**Leader**	**Leader,** FORE					FORE, HardHYPack	
Technical design	Per Gradin	Wood disinteg							
Gasification	Wennan Zhang		Participant, FORE						
Visual Sensor Systems	Mattias O'Nils	Wood disinteg	Participant	Participant		Foggy, SURF			
Radiation Sensor Syste	Christer Fröjdh	XFIBER	Participant	Participant	Paper Solar cells etc.	X-ray			
Detector and Photonic	Göran Thungström		Participant		Paper Solar cells etc., ELGEN	Detectors			Fiberoptik industriell
Sensor Network & Sec	Tingting Zhang			Participant			KITT, DAWN		
Sensor based Services	Mikael Gidlund			Participant, Robust, GRIDLESS			NextPReWIC, M2M_COMS		
Wireless Sensor Syster	**Bengt Oelmann**		Participant	**Leader,** ORESS	Paper Solar cells etc.				FLEX
Power Electronics	Kent Bertilsson			Participant, HF Power converters					OREAS Motor
Realistic 3D	Mårten Sjöström					Plenocap, OMG Character			HET
Printed Sensor System	Johan Sidén			Participant	Iprint, ID Pos, Paper Solar Cells		Mobisense		
Material Physics	**Håkan Olin**				**Leader**, Paper Solar Cells, COAT, KEPS, Modulit, KM2Synergy				Permascand, Kubal
Computational Math a	Per Edström				Paper Solar cells etc.				
Digital Printing Center	Mattias Andersson				Ink-media, Paper Solar Cells etc. FILM	Optics, illumination projects, SURF			Digi printing projects
Organic Chemistry	Armando Cordova				COAT			Eurostar Paperboard	
Complex Materials	Tetsu Uesaka				COAT, Surf eng			FORE, Reliability, COMPAC, Microfluidics	
Surface and Colloid En	Magnus Norgren							FORE, COMPAC, Guest prof Bio	Uniclean 2.0
Ecochemistry	Erik Hedenström							FORE	

Appendix D – Reports of KK Research Actions 2013

ACTIVITY REPORTS

HALF TIME REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	Industriinitiativ energieffektiv tillverkning av mekanisk massa - Energy Efficient Mechanical Pulping – Research Profile (e2mp-rp)
Project leader	Per Engstrand
Ref. no., KKS	20100281
Project time	2011-04-01--2017-03-31
Report period	2011-04-01--2013-12-31

The total annual pulp production in Sweden 2012 was 12,0 Mt of which 3,6 Mt was mechanical pulps it should be emphasized that virgin pulp production in Sweden is increasing while recycled pulp production is decreasing due to high pricing on recycled paper. Mechanical pulps are used in various printing and packaging products with an annual export value of 20-30 billion SEK. As electricity prices have doubled during the latest ten years and that the key elements of the mechanical pulping processes, fibre separation and fibrillation consume about 6 TWh/y, it is important to understand how to improve the energy efficiency of the production processes. The technical goal of the research profile is therefore to use an academy-industry research co-production strategy to find new and/or further develop earlier suggested technologies to reduce the specific electric energy consumption of the processes by as much as 50%. The project portfolio suggested in the original application is shown in Figure 1.

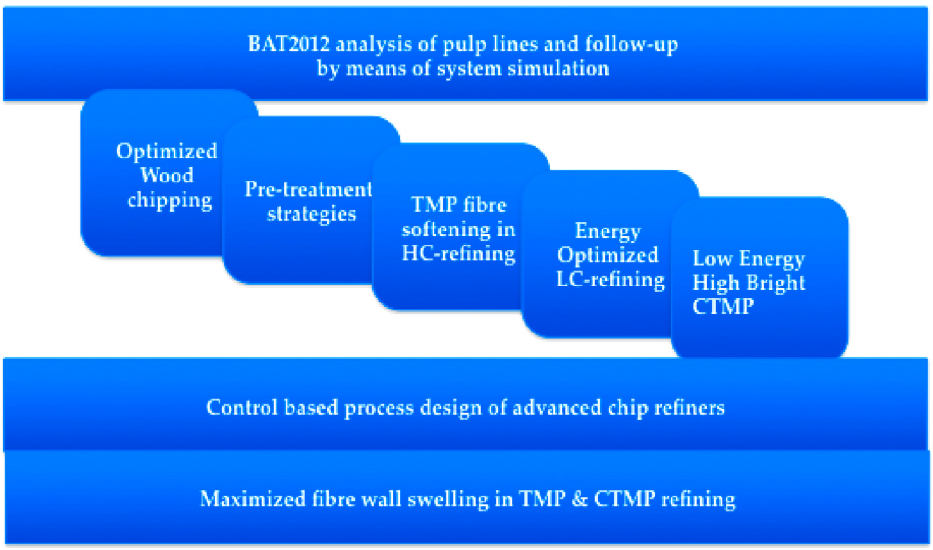


Figure 1 - The project portfolio of e2mp-rp suggested in the original application.

During the first half of this research profile (2011–2013) a series of projects have been started according to the intentions of the original outline, see Table 1. The project portfolio is mainly designed to achieve the general goals for the research profile, but at the same time also balancing the efforts with capabilities of the participating companies and of FSCN-MIUN respectively.

Table 1 - The active project portfolio; title, project leaders and objectives for the profile projects.

Project titles	Project leaders	Project objectives
BAT-2012	OB/OF	Establish a base line - today's best available technology (BAT) for production of TMP and CTMP pulps
Chip-pretreatment/DD-refining - demo scale	EN/BE	15% improved energy efficiency
Efficient LC-refining – pilot- and demoscale	CS	300 kWh/adt reduction in electric energy consumption
Pre-treatment strategies for high yield pulps (HYP) – lab & pilot scale	LL/BE	30% improved energy efficiency
Refining of softened TMP fibres	BE/HH	400 kWh/adt reduction in electric energy consumption
Chip refining efficiency	RF	300 kWh/adt energy reduction for newsprint TMP and the consumption should be lower than 1250 kWh/adt within existing equipment
Fibre Development	OF	Prediction of fibre/pulp-properties = f(unit process combinations)
Faculty financed projects		
Maximized fibre wall swelling	HF	Improved understanding of fibre wall swelling mechanisms as tool to reduce energy consumption
Quantifying mechanical treatment during chipping	LH	Improved understanding of crack propagation in wood matrixes as a tool to reduce energy consumption
OB – Olof Björkqvist, OF – Olof Ferritsius, EN – Erik Nelsson, BE – Birgitta Engberg, CS – Christer Sandberg, LL – Louise Logenius, HH – Hans Höglund, RF – Rita Ferritsius, HF – Helena Fjellström, LH – Lisbeth Hellström		

Some of the projects have already reached their technical objectives. For example, "BAT-2012" will be finalized, reported and ended by 2014-03-31. The project has been very appreciated among the forest industry companies and the conclusion is that not only has a reference line of today's best available technologies been established but the careful trials and measurements performed have given a lot of valuable input to the companies running the 16 benchmarked TMP- and CTMP-lines. The "Chip-pretreatment/DD-refining" project has reached the goal of 15% improved energy efficiency but still the project will continue with more fundamental analysis, writing articles and Erik Nelsson will defend his doctoral thesis in 2015. Since Erik now has a new position within Holmen he has only 25% of his time to spend on PhD-studies which delays his work with approximately one year – the original plan was to have the PhD-defence in 2014.

Other projects started with a more fundamental approach and lab-scale studies. For example, "Pre-treatment strategies for high yield pulps" has started out with most of the experimental activities performed in lab-scale. To reach the technical goal of showing how to increase energy efficiency with 30% more of the activities are now carried out in pilot-scale. This is also an approach that will be used in the next three-year period. More activities are planned for pilot or full scale while parallel lab-scale studies will support these. Also the faculty financed projects have predominantly focused on lab-scale studies and theoretical approaches during the first three-year period of the research profile. The focus on lab-scale will probably continue during the next period as well, however, more pilot and full scale activities will most likely be carried out in cooperation with the other projects.

"Fibre development models" is a project that has started only recently, 1 January 2014 and also the "Chip refining efficiency" project has only been run for a little more than one year. We also plan to include a CTMP project focusing on hardwood in the research profile (possible board decision in May) and start a project using control-based process design to create a more efficient process during the last three-year period. When these projects are started the project portfolio will be very similar to the plan in the original application. In conclusion, we feel confident that the projects will reach their goals and contribute to the overall goal of the profile – to show how to reduce electric energy consumption by 50% while maintaining important fibre properties for the products.

Scientific results

Results from the individual profile projects are summarized for each project below.

BAT 2012 analysis of pulp lines and follow-up by means of system simulation

The aim of this project was to establish a base line, from where to reduce the specific electrical energy level, by defining today's best available technology (BAT). Almost 200 pulps where sampled at normal operating conditions in 16 TMP- and CTMP-lines for publication and board grades, this was done in order to cover as many as possible of the current technologies. The pulp lines and pulps were analyzed thoroughly both with regard to power consumption, production/flow measurements and by means of laboratory analyses.

The project was financed by Norske Skog, Holmen, SCA, Stora Enso, the KK foundation, the Swedish Energy Agency, Åforsk, and ÅF AB. The production lines evaluated are the most energy efficient according to the participating forest industry companies.

The quality profile of the pulps produced in the lines differed a lot, even for similar product grades, see Figure 2 and 3. The lowest amount of specific refining energy was for the publication grades 1800 kWh/bdmt, while it was 2760 kWh/bdmt for SC grade. Corresponding value for the board grades was 840 kWh/bdmt. However, depending on mill specific requirements due to furnish, grade, paper and board machine etc. it may be that the BAT will end up with higher levels of specific energy in order to maintain the functional properties of the product. There was no pulp line, which could be consisted to have the most energy efficient unit process in every stage. The most energy efficient lines were operating at the highest production rates and with high relative speed of the refiner discs. The screen room configuration in the investigated lines differed a lot. With respect to the final pulp quality there was no obvious influence of how the screen room was equipped. It was possible to develop the fibres in a proper way just by refining of the whole pulp stream at low or high consistency.

Based on this study the following hypothesis can be postulated: "Correct conditions in the primary refiner stage followed by a very simple post treatment which develops the fibres just enough to the required level is a feasible way to reduce the specific energy consumption in mechanical pulping".

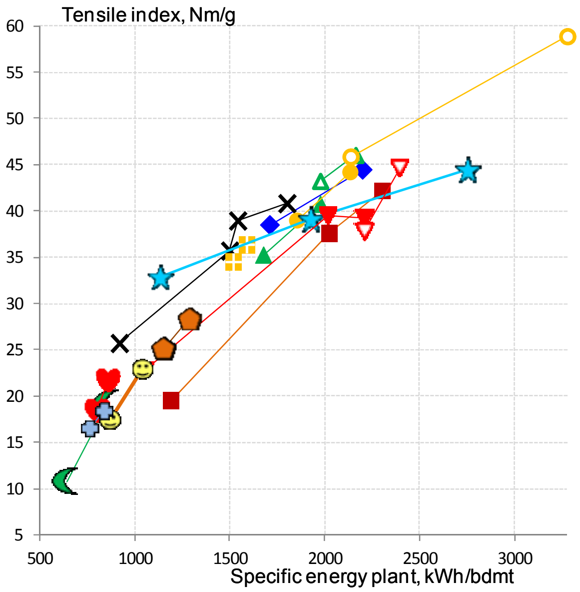


Figure 2 - From the benchmarking study of 16 TMP/CTMP-lines. The different markers represent individual production lines. A tensile index of 40 Nm/g was reached for the publication grades in the range of 1700-2300 kWh/bdmt. The board grades reached a level of 20 Nm/g at a range of 800 to 900 kWh/bdmt.

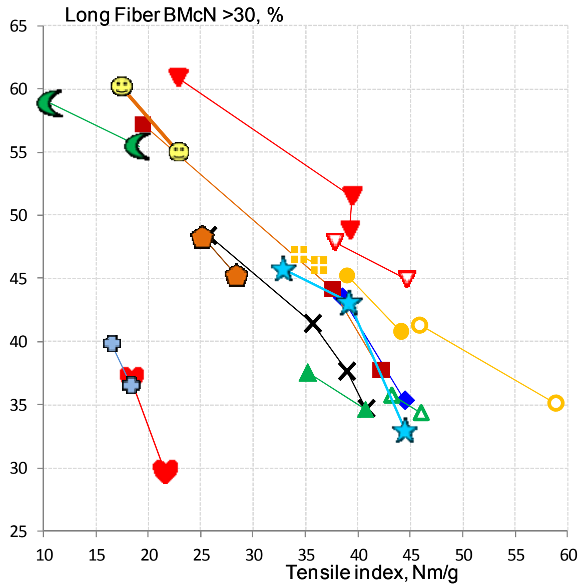


Figure 3 - At a tensile index of 20 Nm/g the amount of long fibres varied from 33 to 58%. At a tensile index of 40 Nm/g the amount of long fibres varied from 34 to 45 %. The different markers represent individual TMP/CTMP production lines.

Pre-treatment strategies for high yield pulps - TMP, cTMP and CTMP qualities

In this project, the objective is to develop new pre-treatment strategies that can reduce the energy needed to produce high yield pulps (TMP and CTMP qualities) by 30% while maintaining similar pulp properties. Chemical pre-treatment have potential to reduce energy consumption since, for example, sulphite, peroxide and alkali introduces charged groups in the lignin which facilitates the fibre separation. To reach maximum effect of traditional as well as new pre-treatments we need increased fundamental knowledge of how wood properties can be changed and how this can be related to refining conditions and the character of the final pulp. In the first part of this project the objective has therefore been to study how wood mechanical properties are changed after chemical pre-treatment. Sulphite pre-treatment (sulphonation) was chosen as a reference since that is the most common and well documented pre-treatment of today. In the literature there are examples where wood chips sulphonated at a low pH resulted in pulp with lower freeness and higher light scattering than chips sulphonated at alkaline pH despite lower energy input in the refining stage. According to the mechanical testing carried out in this project, this can probably be explained by the fact that wood material sulphonated at low pH (pH 4) is considerably stiffer than the well softened material that is achieved at alkaline pH, see Figure 4. At a given refining intensity (deformation rate and amplitude) it is likely that a stiff material undergoes more plastic deformation than a softened material. This means that more of the applied energy leads to structural changes in the material. Also friction measurements (wood-steel surfaces) were used to study sulphonated wood material at different pH, see Figure 5. Sulphonation at alkaline pH led to increased friction which can probably be explained by that a larger part of the wood surface and bulk were deformed in the contact. More energy can therefore be transferred to a softened wood material in sliding contact; however, most likely a large part of this energy goes to hysteresis losses in both the wood surface and bulk. Thus, to be able to refine a well softened material it seems important to achieve large deformation "amplitudes", large deformations and high deformation rates, both to increase the plastic deformations and reduce the hysteresis losses.

It is both costly and time-consuming to perform pilot- and full scale trials, especially using new untested chemicals and without knowing in what direction to go for adjusting the process (refining gap, temperature, production, …) to get most out of the pre-treatment. Based on mechanical testing, literature studies and the combined knowledge in the project group a series of pilot-scale trials will be carried out starting in February 2014 – to investigate new pre-treatments and process conditions.

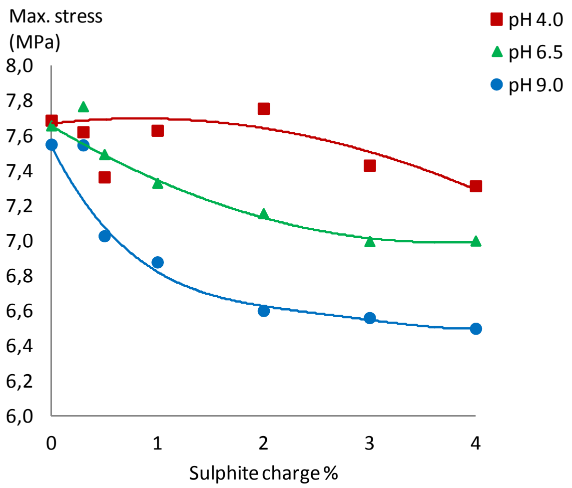


Figure 4 - Results from shear testing (in room temperature) of wood samples sulphonated in solutions of different pH (4,6.5 and 9).

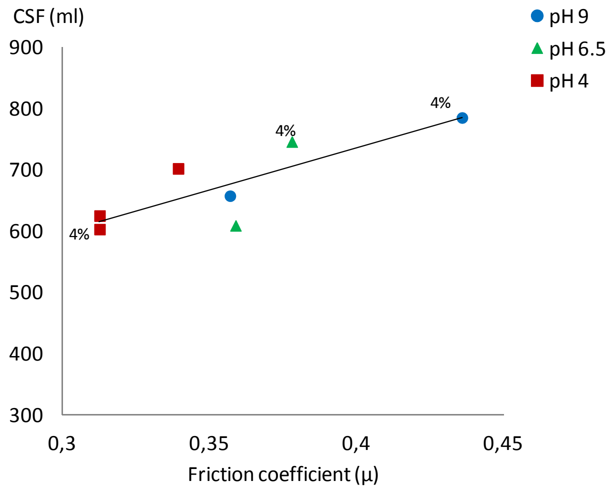


Figure 5 - Freeness of sulphonated wood chips wing refined at 1500 kWh/t correlated to the registered friction coefficient between sulphonated wood samples and a smooth steel surface.

Chip pre-treatment combined with high intensity DD-refining

The goal of the project is to examine if the electric energy consumption in a modern TMP process can be reduced by 15% by means of combining wood chips pre-treatment with increased refining intensity. The fundamental hypothesis behind this project is that softening of wood makes it possible to treat wood fibres in a more efficient way using increased refining intensity without negative influence on fibre properties. In this project this hypothesis was tested by combining mechanical chip-pretreatment with softening of wood chips (wood fibres) by means of lignin sulphonation optimized by well-balanced sulphite treatment with increased refining intensity achieved by means of changed refiner segment design. To demonstrate this, five full-scale experiments were conducted at the Braviken Paper Mill (Holmen Paper AB), see Figure 6. The results, see Figure 7, shows that when the chips were pre-treated with only 3 kg sulphite per ton and refined with a high intensity segment design at increased production rate, the electric energy consumption was reduced by 15%. The reference pulp was produced by means of refining with the standard segments without chip pre-treatment and sulphite impregnation to the same tensile strength and light scattering. It should be emphasized that the combination of wood softening and new segment design also makes it possible to increase the production rate by ~ 25%.

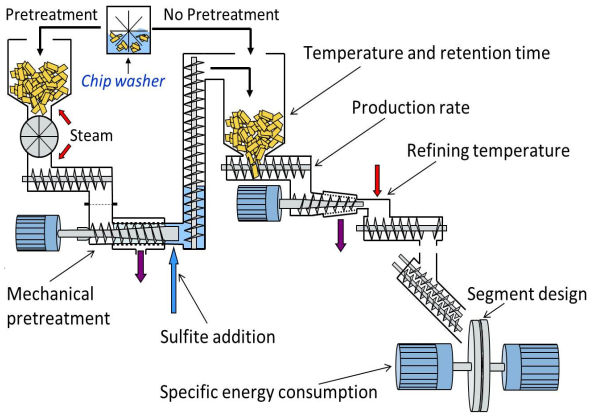


Figure 6 - A schematic description of the process used for the trials in this study. It is possible to bypass the mechanical pre-treatment by sending chips from the chip washer directly to the pre-heater bin. The different process parameters that were studied are shown together with an arrow marking the locations of the parameters in the process.

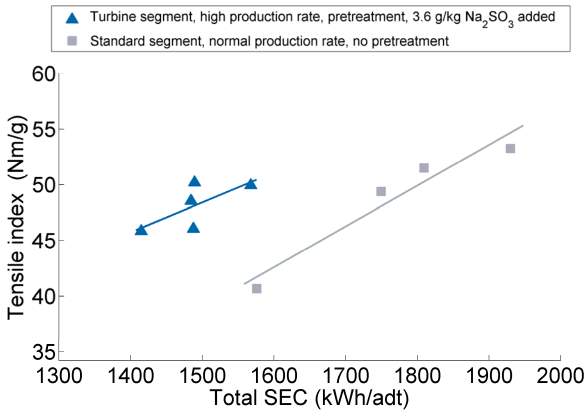


Figure 7 - Tensile index plotted as a function of the total specific energy consumption with both standard and turbine segment design.

Improved energy efficiency in refining of softened TMP fibres

Most of the proposed ways to reduce energy consumption in high-yield pulping involves refining at a smaller plate gaps. However, small gaps can be difficult to control in daily operation. Small gaps are normally achieved when refining at increased rotational speed, at increased refining temperature and when using feeding segments or processing a softened raw material. How small or how large the gap can be during stable refining can also be affected by the segment design. In this project, new segment designs are utilized to introduce forces to the fibre material in a new and different way. The project objective is to develop new refining technology for a reduction in energy consumption of at least 400 kWh/ton compared with today's BAT in commercial TMP-producing installations for printing paper grades. The approach is to develop a plate design that will be able to efficiently treat softened wood fibres i.e. the fibre loading should cause structural changes in the fibre material without cutting the fibres - cyclic loading of the fibres in the visco-elastic region should be minimized.

A few pre-trials have been carried out in a ROP 20 single-disc refiner under atmospheric conditions using a high-freeness CTMP as the starting material. The new segment holder and the new type of segments were placed in the stator while one traditional (standard) and one feeding segment were used in the rotor. From the trials it was found that refining at high consistency and at high rotational speed was beneficial. No fibre shortening was achieved even at extremely small refiner gaps. A feeding rotor plate together with the new segments in the stator resulted in extremely stable operation. By using different new segment designs, the refiner could be operated with high load at both small, medium and at large gaps while keeping the production level constant. Normally, refining a softened material using high loads requires small gaps. Most likely, this new technique will be most beneficial combined with high temperature refining or when refining a chemically softened raw material. The operational difficulties, that earlier were related to energy efficient refining of softened fibres, should thus have potential of being substantially reduced. It is known from earlier mill trials that the combination of softening and harsh or intensive refining is successful when it comes to energy reductions. Trials with the new segments in both stator and rotor are planned to start in February 2014.

Improved energy efficiency in LC refining of mechanical pulps

Low consistency (LC) refining is in some mills used as a tool to improve refining energy efficiency and improve the production capacity in TMP, GWD and CTMP lines. Full scale installations have though revealed some current limitations, mainly, the maximum specific refining energy that can be applied, which limits the energy saving potential.

The purpose of this project is to increase the specific energy in LC refining of TMP and increase the efficiency of the refining i.e. attain higher degree of fibre development at a certain SEC. The goal is to reduce refining energy with 300 kWh/adt compared to a BAT TMP line today.

Most of the work in this project will be made with LC refiners installed in mills. The work is focused on two areas; 1. Increasing the loadability, i.e. the maximum specific energy that can be applied to a certain fibre length decrease. 2. Improving the energy efficiency of LC refining itself, i.e. at a certain specific energy, tensile index increase should be larger.

Two pre-trials for chemical treatments before LC refining have been made in mill-scale at Stora Enso Kvarnsveden. During refiner bleaching trials samples were taken out before and after the LC refiner operating as 2nd stage after the primary HC refiner. The results indicate that a combination of peroxide and NaOH have an effect on LC refiner efficiency (SEC for certain tensile index increase). No effect could be seen with peroxide and $Mg(OH)_2$. Unfortunately this TMP line was permanently shut down during 2013, and thus no further trials could be made. It has not been possible to make trials with chemicals in any other mill so far, but discussions are ongoing for the next period.

A pilot trial was performed in Andritz' pilot plant in Springfield to find explanations to the stronger response in tensile index increase in LC refining of DIP compared to TMP and thus find ways to improve the energy efficiency of LC refining. It was found that the main explanation of the higher efficiency of LC refining of DIP is the content of kraft pulp. A conclusion from this trial is that co-refining of TMP and kraft could be utilized to improve the LC refining performance. A possible application could be in a process where TMP is post-refined and where kraft pulp is added (i.e. magazine paper production).

A trial was performed at the Braviken Paper Mill, Norrköping, in order to investigate the effect of flow recirculation on fibre development and refining efficiency. The conclusion of this trial is that re-circulation:

- Helps to keep the refiner in a more stable operating condition.
- Does not have a large effect on the pulp property development (see Figure 8).
- Does not significantly affect the refining efficiency.
- The pulp with recirculation is not more inhomogeneous.

Piping work, to be able to do trials with two-stage LC refining, has recently been finished in the Hallstavik mill. Also new pipes have been installed in Braviken to be able to do trials with LC refining combined with fractionation. No trials have been done yet in either of the mills, but are planned for the spring 2014.

Much work has been made in Braviken to get the large TwinFlo 72 refiner up and running continuously. During the spring 2014 it will be possible to do trials comparing LC refining of DD pulp and SD pulp. Two short trials have shown good potential on SD pulp. To the same tensile index, the refining energy was around 300 kWh/adt lower than a two stage SD line and 150 kWh/adt lower than DD refined pulp (see Figure 9). The TF72 can be used in the next part of the research profile. It is quite clear from these trials, that it is important to have a process with an efficient primary HC refining in order to improve the total energy efficiency. This issue will be addressed in the next period.

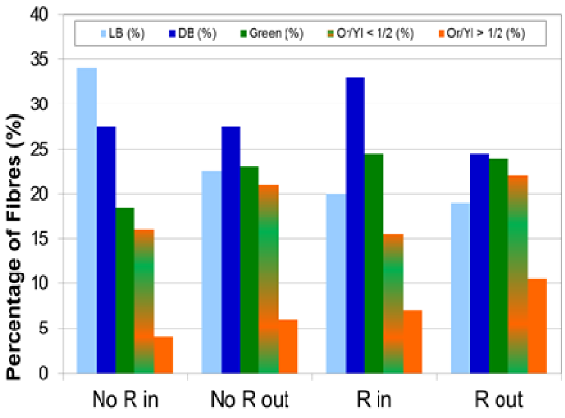


Figure 8 - There was no difference in fibre wall treatment running the LC refiner with recirculation (R) and without recirculation (No R). Light blue is poorly refined fibres and orange is highly refined fibres. Fibre analysis performed with the Simons' stain method.

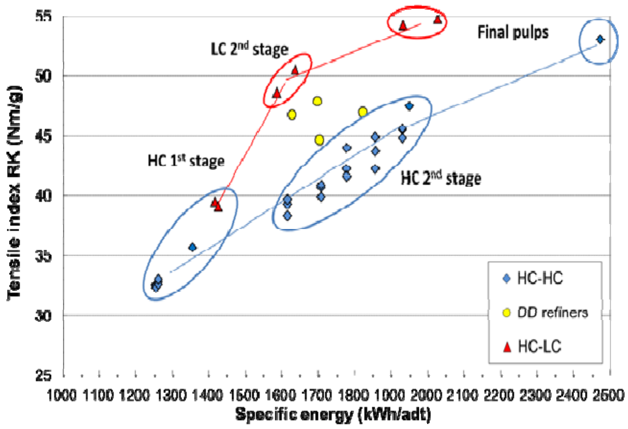


Figure 9 - Comparison of energy consumption for three different refining processes. The HC-LC process is single disc refining followed by the new large TwinFlo 72 LC refiner in Braviken. Tensile index was measured on Rapid Köthen hand sheets.

Energy efficient chip refining

The major part of the electric energy consumption for production of refiner process based mechanical pulps, as TMP and CTMP, is applied in the chip refining. It is therefore necessary to optimize the unit operation of chip refining in the best possible way. One of the subprojects in the Vinnova and Swedish Energy Agency financed project "Filling the gap" (2009-2013) used the same full-scale refiner as has been used until now in this project. This refiner, a Metso RGP82CD situated at Stora Enso Kvarnsveden mill, is equipped with the new and more accurate plate gap measurement AGS from Dametric and temperature measurement arrays from Chalmers Industriteknik along the radius, 8 in the flat zone and 8 in the conical zone, see Figure 10 and 11. As the same refiner was to be studied in this project, the opportunity to coordinate the experimental work was regarded beneficial for both projects. Five full-scale trials were performed and Stora Enso Kvarnsveden performed laboratory analyses of the pulps. Process variables and pulp properties were investigated both when the set points for the process variables were in conventional process mode and when successive step changes were made, see Figure 12. Very large variations in both process variables and in pulp quality can be seen also when the refiner is running in conventional operation. It was shown that it is very important to carefully design the sampling procedure to get statistically valid data during full-scale refiner trials. Having reliable process and pulp quality data it could be shown that similar tensile index level could be reached with a difference of 200 kWh/admt in two trials during the same day and using the same production level. When all tests are considered, the same tensile index level could be reached with a difference of 300 kWh/admt. If energy efficiency is defined by specific electrical energy consumption to a certain tensile index level it seems to be a maximum at pulp consistencies around 50-55% for this specific refiner and this specific wood fibre material, see Figure 13. It was further shown that pulp samples with approximately the same freeness level could have large variations in tensile index and shive content. This indicates that there is a potential to reduce the specific energy consumption necessary to reach a certain tensile index. It is off course also important to have more information of the pulp quality than only freeness and fibre length (commonly available in online measurement) to use for the control of the refiner.

Figure 10 - Photo of the R4 CD82 refiner during montage of temperature sensors.

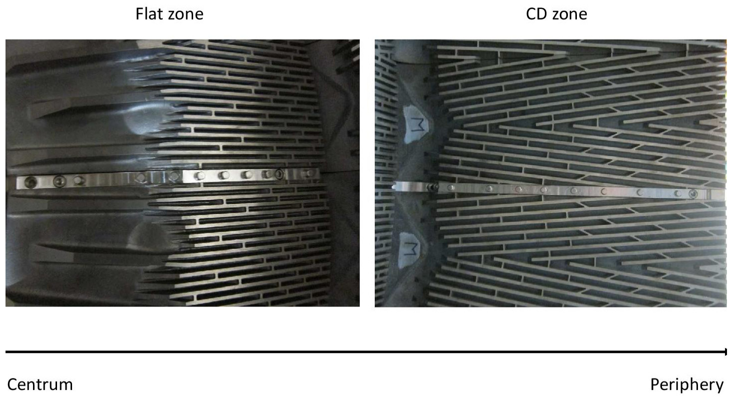


Figure 11 - Photo showing how the temperature sensor arrays are positioned between the refining segments along the refining zone radius. There are 8 sensors in the flat-zone and 8 in the CD-zone.

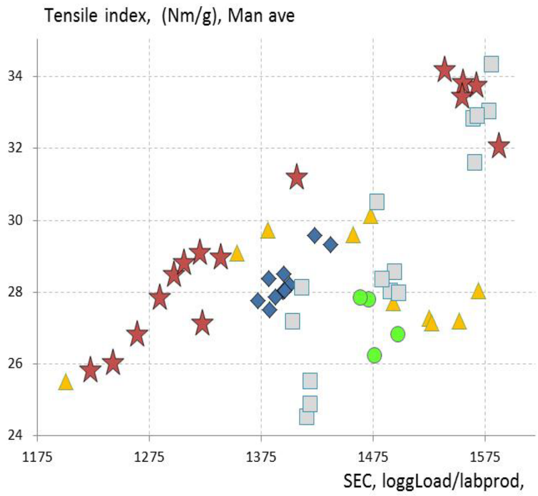


Figure 12 - Tensile index versus specific energy for trial 1-5.

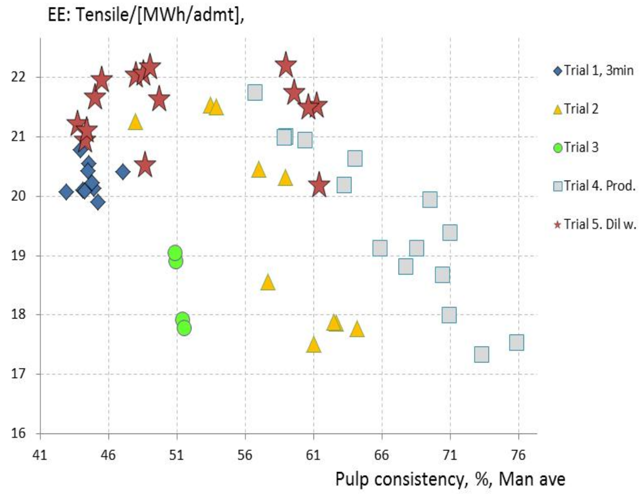


Figure 13 - EE (Energy efficiency with respect to tensile index) versus pulp consistency for all trials.

Fibre Development

The project was started in January 2014. The general project idea, when considering pulp quality and energy efficiency, is to:

- make it possible to combine results, conclusions and insights from all the other projects within e2mp to be able to reach the e2mp objective of reducing energy efficiency with 50%
- propose ways to evaluate different pulp line concepts (up to disc filter or equivalent position) for various end products

- develop mathematical models to describe unit processes and quality in CTMP/TMP lines and by this develop a better understanding for the interactions between fibres, pulp and products

Energy efficiency by means of control-based process design
This project is planned for start-up after the first three-year period.

Maximized fibre wall swelling in TMP and CTMP refining
When producing high-yield pulps the fibre separation will take place in the weakest part of the wood matrix. The position of where the weakest part of the wood matrix is situated can to a large extent be controlled by adjustment of the swelling and softening properties of each of the wood polymers. The combination of position of fibre-fibre separation together with the efficiency of the external and internal fibrillation will to a large extent determine the energy demand to produce high-yield pulps. In order to improve the level of knowledge on how to influence the degree of wood matrix and fibre wall swelling of high-yield pulps we have undertaken to study the swelling properties of these fibres. The influence of sulphonic and carboxylic acid groups in combination with the effect of counter ion form and temperature, on the fibre wall swelling of high-yield pulp fibres was studied by means of water retention value (WRV). In the first trial, unbleached TMP, peroxide bleached TMP and peroxide bleached HTCTMP were ion exchanged into H^+, Na^+, Ca^{2+}, Mg^{2+} and Al^{3+} form, and then their WRV were measured in the temperature range from 25 to 95^{o}C. It was found that pulps not containing sulphonic acid groups need to be heated above the softening temperature of lignin in order to be able to swell to their full capacity. Introduction of sulphonic acid groups also opens up the rigid structure of lignin which lowers the softening temperature and increases the swelling potential even at lower temperatures. The effect of valence of the counter ion was also shown to be more pronounced after adding more carboxylic acid groups to a pulp. In the second trial, unbleached spruce TMP taken from the blow line was treated with hydrogen peroxide and sodium sulphite during conditions resembling those used in chemimechanical and bleaching processes commonly used in the industry. When subjecting sodium sulphite treated pulps to a subsequent hydrogen peroxide step, all pulps show a decrease in sulphonic acid groups, which could be owed to dissolution of highly charged lignin. Pulps treated with a high hydrogen peroxide charge (4%), showed a loss in carboxylic acid groups during subsequent treatment with sodium sulphite. This loss is probably due to dissolution of highly charged fibre material such as demethylated pectins. Both increased degree of sulphonation and carboxylation of the lignin reduces the softening temperature by means of reducing the degree of cross-linking in the lignin matrix. This softening probably improves the compressibility of the fibre pads in the sample holders of the WRV centrifuge, which would counteract an otherwise expected increasing WRV-value due to increased swelling potential. This makes it difficult to see clear trends in WRV as a function of increase in degree of sulphonation and carboxylation. When changing counter ion form from proton or calcium form to sodium form there is however always a clear increase in WRV in the range from 20 to 30%, see Figures 14 and 15.

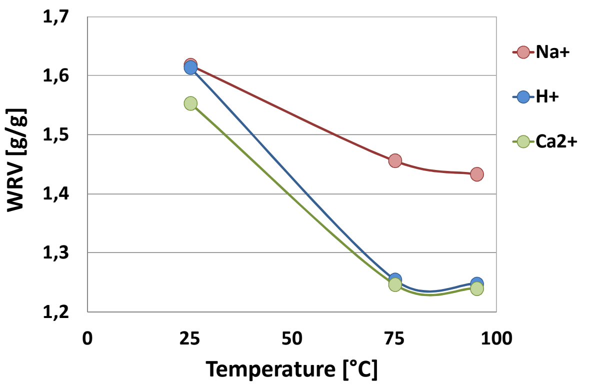


Figure 14 - Influence of ionic form (Na+, H+ and Ca2+) of peroxide and sulphite treated TMP fibres with a total charge level of 269 µmol/g, on the water retention value in a temperature interval of 25 to 95°C.

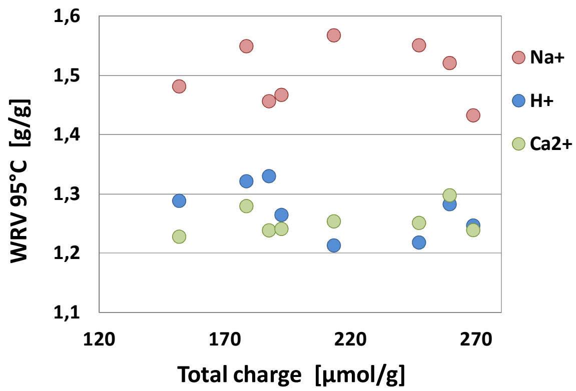


Figure 15 - Water retention value measured at 95°C as a function of the total acidic group charge of pulp with different counter ions.

Chipping technology for improved energy efficiency

The activities in this project deviate to some extent from what was put forward in the original application. This is partly because many of the planned activities are parts of an existing (KK-financed) project. However, the topic of this project is also directed towards wood chipping, however the chipping that is performed in the sawmill industry. Since wood chips from sawmills is a large part of the chips used in the pulp and paper industry the so called chipper canter process is also of interest – where the circular cross section of a log is reduced to a quadratic form. In Figure 16 is shown the second of the two stages of the canting process. More specifically, theoretical models were here developed by which it were possible to estimate the power needed in the two sub-processes which constitutes the canting process. One sub-project with a clear experimental focus was also included. The result of this project, so far, is a mathematical model that can be used to estimate the power needed for canting of arbitrary log dimensions, feeding rates, canting strategies etc., see example in Figure 17. The work has this far resulted in three journal publications; two in NPPRJ and one in Holzforschung.

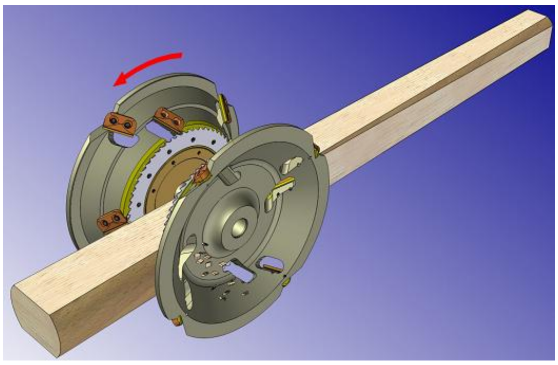


Figure 16 - The second of the two stages of the canting process.

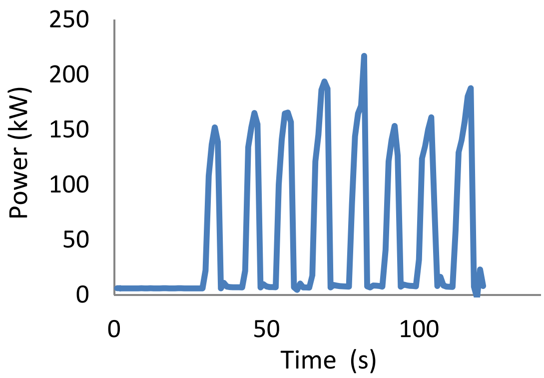


Figure 17 - Results from a field trial. The power consumption during canting of eight logs in a sawmill. The maximum value represents the power value at the root end of the log. The mathematical model predicts a value of 185 kW.

Co-production process

The KK foundation and the participating companies invest 36 MSEK each and MIUN invests 12 MSEK in the research profile. The research profile is a part of a larger industrial energy initiative started by forest industry companies in Sweden and Norway; Holmen, Norske Skog, SCA and Stora Enso as the main partners. The Norwegian Research Foundation and the Swedish Energy Agency finance the other parts. In total the industry and the governmental authorities are investing 200 MSEK about 50% each, detailed information is found on the web page http://e2mpi.se/.

Here some more practical information about our co-production process. For all projects, except for the faculty financed projects, decisions regarding project planning and activities are taken in the project groups. (The faculty financed projects also have industry-academy references groups to consult whenever needed.) Each project group consists of members from all project partners (participating companies and MIUN). When activities are agreed upon in the project group it is also decided what the different parties can and want to contribute with. For example, a lab-scale trial can be carried out at SCA R&D Centre by MIUN and SCA personnel, standard testing can be performed in the Stora Enso research lab while other types of analysis can be done by Holmen and MIUN.

All projects, including the faculty financed, continuously reports planned activities, results and deviations from time-plan to the profile board in the form of short status reports. This makes it possible to share results and cooperate in an efficient and still controlled manner. Mill-based meetings, mini-seminars, have been successfully used to spread information about e2mp and the project results within the participating companies and also to increase the involvement from the companies. We feel that the company's involvement and engagement in the research profile in general is very high. One indicator that supports this is the very high degree of participation that we have in meetings at all levels (both project meetings, profile meetings (mini seminars) and profile board meetings.

Scientific quality and profiling

The research profile is described as a strategic initiative in the FSCN-STC Work plan for 2014-2016. The profile, and the projects it consists of, also contributes in a straight forward way to reach the goal in the TIE strategy of the MIUN KK Environment to further develop its position as world leader in the technical research field of High Yield Pulping Technology.

The research performed in the e2mp-profile is based on solid technical and scientific ground. One could say that there are four cornerstones behind building a successful research profile in the area of high yield forest fibre utilization:

1) Fundamental wood fibre material knowledge
2) Fundamental unit process knowledge
3) Process systems understanding on a fundamental level
4) Understanding of quality measurements and process control aspects

In addition it is crucial to understand how to combine these knowledge areas including the different persons who are experts in these areas to make joint efforts in order to together with the companies achieve both scientifically and technically good results.

FINAL REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

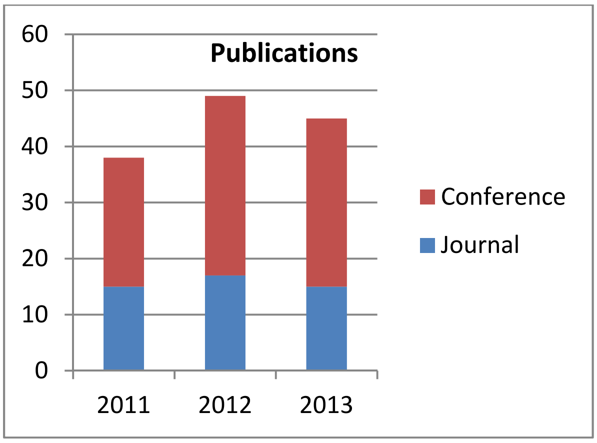
Name of project/action	STC Industriell IT
Project leader	Mattias O'Nils
Ref. no., KKS	20100318
Project time	2011-10-01 – 2013-09-30

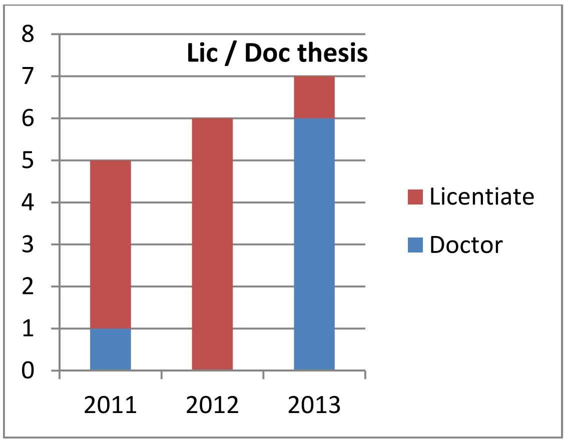
Results

For the two year of Profile+ funding the research environment has built the research into higher quality research, better profiled focus and integration with the now established KK-environment at Mid Sweden University.

The project Profile+, STC Industrial IT, has followed the initial plan, the production is well over the expected and the goals specified in the project plan will be fulfilled. The project has been an important part in the strategic process formulate goal for the strategy in the MIUN KK-environment. STC Industrial IT has lead to the formation of the new profile proposal EnergyWiser, which is a focus onto industrial embedded sensors for increased energy efficiency and energy production. The project has produced co-production and also has produced high quality research in numbers of research articles.

Scientific goal fulfillment: The scientific goals in the project can be divided into two parts, one which relates to the content based goals in the project reported in next section and one which relates to academic production and quality process. As for the latter, the researchers in the project have produced a large number of publications of which one third is published in journals and two thirds in conferences. Both the quantitative production and the higher fraction of journals show a large increase of the research production compared to the previous profile. The high publication rate can be explained partly by an active selection of journals and that the research environment has several PhD students in the later stage of their studies. A goal has been to graduate a high number of high quality PhD's. In the project 7 PhD was examined and 10 PhD students got their licentiate degree. The academic production is illustrated below.





Communication goal fulfillment: Part of the project has been to fulfill the communication goals, this focus on building structures to attract new coproduction partners; this has been implemented by permanently establishing the information conference STC Expo with 100+ participators per year from industry and academia, repeated visibility in selected media and professional magazines and a frequent involvement in the popular science and professional IT conference Sundsvall 42.

Profiling goal fulfillment: The goals of profiling the research environment has been focusing on building an international profile from research center STC, which also includes the drive and support from the region. This has been captured as goals:

- To improve the profile's role at the university; STC has during the project become one of four profiled research centers at the university, where STC is one part of the Mid Sweden University. The main strategic contribution from STC into the KK-environment is the strategic is the profile in industrial distributed and embedded sensor systems (EnergyWiser) that is developed from this project.
- Integrate with the innovation system; during the project has Fiber Optic Valley changed their strategic direction into a strategy that fully matched in STC's profiled research.
- Clear national role in interaction with Acreo; The creation of the new profile EnergyWiser, recruitment of adjunct professor from Acreo and the interaction with the forest industry research center FSCN in the KK-environment makes the research unique in Sweden.
- Clear international profile for the focus areas that is clearly presented; The development of EnergyWiser is a development to make the focus area more clear and unique.
- Develop the areas in STC to give a clear contribution to the KK-environment at the University; EnergyWiser is a one of the strategic fundaments of the MIUN KK-environment, and the printed electronics part of STC IndIT has now focused on the large functional surfaces named KM2 (kilo meter square) in the KK-environment. The remaing measurement technique activities is a resource for process measurement in the KK-environment context.

International goal fulfillment; the goal is formulated to build co-operation on a European level with the purpose to increase the academic quality and co-production but also to attract new funding from the European frame work. At least five clusters have been established that will be used in formulating new actions in the Horizon 2020 program.

Deviations from the plan; The main difference compared to the plan, is that the professor in Sensor Services Technology has moved to another University, which has led to a new recruitment which better fits the new strategic formulations around embedded and distributed sensor systems (EnergyWiser).

Co-production

The research has developed according to the plan, except for the exchange of the professor in sensor based services for a professor in industrial communication systems, recruited from ABB. This change has been handled in subproject 1 and has not affected the plan in this short project. This personal changed has helped in the strategic focus into embedded and distributed industrial sensors. The selected demonstrators; a topography measurement system for paper industry and a failure detector for hydraulic motors have been used to integrate the subprojects challenges and to highlight the ideas that have now developed into the EnergyWiser profile. The two demonstrators have developed into two innovation cases that are now handled within the Mid Sweden University pre-incubator structure for commercialization of the technology. Apart from these general interactions with the industrial partners, the specific coproduction with the partner companies and the specific research challenges are presented below. Two companies (VisualEyes and Gunnebo Gateway) have interacted in the project that has resulted in publications and patents, but due to owner and organizational changes have not been able to contribute formal cofounding. This has been handled by the increased coproduction with ABB, SenseAir, Combitec and Rti.

Subproject 1: Communication and service infrastructure (Partners: ABB, SenseAir)
In the subproject we have develop methods for fast wireless control and optimization of these networks together with techniques for context aware authentication for these kinds of sensor networks (together with ABB). Together with this, we investigate techniques for distributing data on a larger scale. For this, gateway functionality for ad hoc deployment of sensors has been developed (where SenseAir has been part of the evaluation).

Subproject 2: Surveillance based on printed sensors (Partners: Gunnebo Gateway, SCA)
The work on surveillance with printed sensors has addressed system integration on flexible substrates on areas that are seen as large in the context of electronics and where sensor-readout is performed with technologies related to RFID. Gunnebo Gateway has contributed to system integration and SCA with paper technology knowledge combined with end user requirements.

Subproject 3: Optical surveillance (Partners: Combitech, VisualEyes, SCA)
In the subproject, new methods for improving detection of markers has been develop for use in logistics chains. Additionally, extend concepts of "intelligent camera" into multi spectral bandwidth imaging is investigated, and methods for detection of ice on surfaces. To achieve low cost, real-time processing and wireless operation we have developed design methods for machine vision systems on FPGA. The first part is done with Visual Eyes and SCA and the two later with SaabCombitech.

Subproject 4: Wireless sensor systems (Partners: ABB, SenseAir)
In the subproject, new techniques for on rotor sensors have been investigated. That is, methods for power transmission to the on-rotor sensor and analysis of the radio communication to the sensor. Additionally, architecture for complex wireless sensors has been developed and evaluated for both vibration measurement and visual sensor nodes. The work is done in interaction with ABB.

Subproject 5: Radiation based surveillance (Partners: Rti, SiTek, SenseAir)
There are three main areas that have been addressed in the subproject; IR absorbers, PSD position sensors and detectors for dosimeters. We have investigated the best way of integrating absorber structure into the process of the fabricated thermopile in IR detectors and developed/analyzed an improved position sensitive detector, with faster rise/fall time, improved radiation hardness and better accuracy.

Quality and profiling

The Profile+ STC Industrial IT, has the overall vision "To become the national leading centre for development of sensor based technology that enables services that results in added value through remote presence in industrial applications". The Profile+ project has been a strong contribution in the development of the new STC strategy within the MIUN KK-environment. The project has influenced the strategy with a stronger focus on Industrial IT and with the conclusion to focus especially on Energy (both production and consumption) applications the coming years. That makes this project an important part to fulfill the goals of the common goals defined in the TIE strategy (Transforming the Industrial Ecosystem). In these process strategic areas has been formulated, relevant areas here are Embedded Sensing implemented in a new profile called EnergyWiser and Large Functional Surfaces implemented in a coming profile KM2. Additional supporting areas are identified as; Industrial Communication and Measurement Systems, these have the role of supporting the strategic areas with competence in moving towards a transformation of industry.

An important part of the STC IndIT project has been to transform the research in STC into support the strategies and visions formulated in the KK-environment. This transformation is described in Figure 1, where it is shown that the sensor network parts of STC Ind IT is included into Embedded Sensing, where the service part of it is formatted under the supporting area of Industrial Communication. The full activities of Wireless measurement systems are included into Embedded Sensing together with high performance embedded computing of Optical Surveillance.

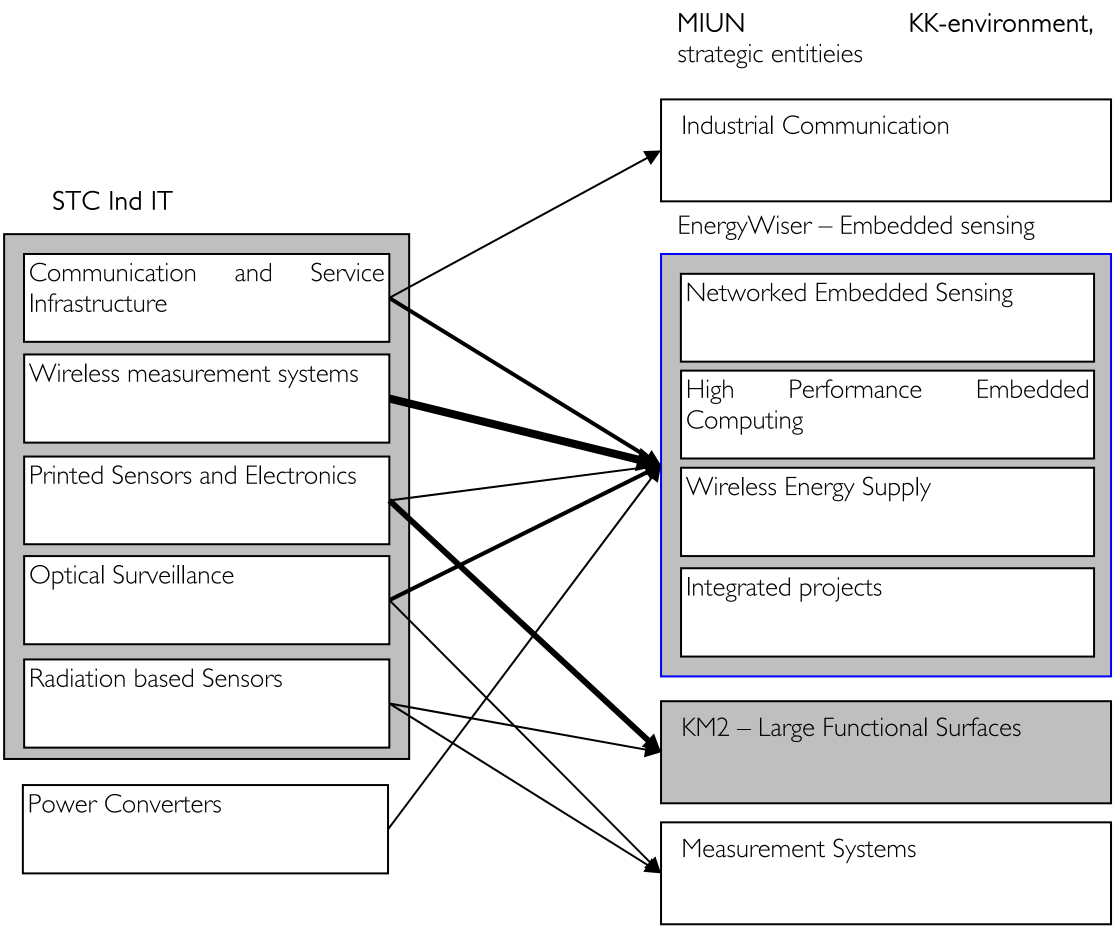


Figure 1. Strategic profiling towards the KK-environment done in STC IndIT project.

Parts of the Printed Electronics activites in STC Ind IT has together with the research group in Power Convertes to form a new area of competence, which is the Wireless Energy part of Embedded Sensing. The last area of the project, Radiation based Sensors will be an important part of establishing the profile areas of Large Functional Surfaces.

Apart from the strategic profiling, the following actions have been done:

- Jan Andersson at Acreo has been appointed an adjunct professorship, to tie Acreo and STC closer together.
- VinnVäxt center Fiber Optic Valley has adopted a new strategy that includes the whole research at STC, which will be a strong resource to support the research environment with both input companies to new research and boosting commercialization of innovation from the research environment.
- MIUN has appointed STC to a formal research centre.
- The research groups in STC has established co-operation within several different areas and taken part in EU-program applications.
- The research has been evaluated and found to have high quality in most aspects, but excellent in coproduction and in impact.

FINAL REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	SysPack – Research on new system integration tools for printed intelligence in packaging applications
Project leader	Hans-Erik Nilsson
Ref. no., KKS	20100263
Project time	2011-01-01—2013-12-31

Summary – scientific results

The project has targeted both long-term basic research challenges and medium term technology development of industrial interest today. The combination of these perspectives has created a dialog where the industrial perspective is challenging and questioning the long-term approaches in the basic research. At the same time the basic research ideas and 'out of the box' thinking has challenged the industrial perspective. These discussions have led to the formation of a research vision on Large Functional Surfaces (LFS) within the Knowledge Foundation program at the Mid-Sweden University.

This visionary work is one of the most important and strategic output of the project since it outlines a roadmap for development for the research field. Syspack has provided an arena for strategic discussions as well as provided the resources to test and to define technology solutions and knowhow for a larger program on Large Functional Surfaces.

Technology solutions and knowhow developed:

- Soap film coating technology – demonstration and characterization
- High performance multilayer interconnect systems – patterned aluminum and multilayer conductive printing
- Characterization of surface mount technologies for patterned aluminum and printed conductors
- Material modeling framework for nanoparticle based matrices

The project has resulted in 32 scientific articles and 5 demonstrators.

Summary – work packages and deliverables

The project includes 4 work packages and addresses scientific questions on both system level and technology level. Some tasks in the work packages integrate both of these perspectives and some task is only focusing on one perspective.

Summary of results in work packages:

- Electrically sintered nanoparticle based two-terminal devices and contacts
  - In depth studies of the sintering mechanisms of nanoparticle inks on porous substrates (6 article finalized)
  - Characterization and analysis of contact formations on materials suitable for system integration of electronic functionality on paper based packaging solutions (2 articles finalized)
- Self-organization of printed two-terminal devices and contact structures
  - After evaluation we have settled on a novel self-organizing method, called soap-film coating (SFC), allowing nano-thin layers to be coated at high-speed (m/s) and several device systems using SFC is under evaluation. (13 articles finalized).
- MD simulation of nanoparticles and mathematical particle methods
  - Numerical modeling of the sintering process to gain in-depth understanding of the physical mechanisms involved in the electrical sintering process. Using molecular dynamics we have studied the sintering process and a related device called memristor (6 articles finalized).
- Demonstrator design and evaluation
  - Five demonstrator setups have been developed and evaluated. The learning process around the demonstrators has resulted in 6 articles.
  - Characterization of edge roughness effects on microwave antennas produced by dry phase aluminum foil patterning (2 articles)

Summary – Milestones

Milestone 11 to 13 have been reached according to plan.
Milestone 21 to 23 have been reached according to plan.
Milestone 24, due Dec 2013, changed focus towards layered materials, new target reached
Milestone 31 and 32 have been reached according to plan.
Milestone 33, due Oct 2013, changed focus towards DFPM, new targets reached
Milestone 41 has been reached according to plan.
Milestone 42 and 43 have been reached but not reported (reporting will be done during 2014).

Summary – changes in the work plan

There has been one major change in the work plan for the project and this is related to the research on DNA based self-assembly. We have found it to be more important to develop and to study patterning processes i.e. light based printing of layered materials. This decision was made after initial tries with DNA and the soap-film coating method developed and targeted within the project.

Summary - Co-production

In the following summary the results obtained through co-production will be described. The wider perspective in the co-production including planning and discussions are described in an appendix to the report.

SCA R&D Center

The co-production can be summarized as joint research on printed RFID sensors for packaging applications. The coproduction has included circuit design, material characterization, climate chamber studies and application demonstration. Three journal articles has been published with authors from SCA R&D center and the titles provide a good description of the work.

- Investigation of humidity sensor effect in silver nano-particle ink sensors printed on paper
- System Integration of Electronic Functions in Smart Packaging Applications
- Inkjet Printed Silver Nanoparticle Humidity Sensor With Memory Effect on Paper

SCA R&D center has also provided experimental support that made it possible to publish the following titles in academic journals.

- Paper surfaces for metal nanoparticle inkjet printing
- Evaluation of Coatings Applied to Flexible Substrates to Enhance Quality of Ink Jet Printed Silver Nano-Particle Structures
- Contacting paper-based supercapacitors to printed electronics on paper substrates
- Assembling surface mounted components on ink-jet printed double sided paper circuit board
- The influence of paper coating content on room temperature sintering of silver nanoparticle ink
- Supercapacitors with graphene coated paper electrodes

Sweprod

The co-production has been focused on manufacturing of demonstrators and discussion regarding printing and assembly issues. Sweprod provides production resources but has not taken part in writing of scientific articles. However, demonstrators produced by Sweprod has been used in the following journal titles.

- System Integration of Electronic Functions in Smart Packaging Applications
- Modified EAS Tag Used as a Resistive Sensor Platform

The demonstrator development is located in the end of the project and during 2014 a number of additional articles will be submitted based on the work of Sweprod. Sweprod has also provided manufacturing of show case demonstrators presented at the STC Expo event (v42 every year).

Oregon Scientific

The co-production has been mainly focused on application specific demands and boundary conditions for high volume chip attachments to flexible webs. Oregon Scientific has supported the project by expertise involved in their product development competence network currently developing wireless sensor solutions for IKEA. The key player dialogue has been the ASIC design provider Shortlink and the Chinese high volume manufacturing partner. Through Oregon Scientific the project has got access to different chip technologies as well as chip attachment knowhow. A number of scientific publications are in the pipeline regarding chip to web attachments. These articles will be submitted during 2014. A number of experimental results from these studies has been *reported in the more comprehensive 50 page internal report for the Syspack project.*

Webshape

The co-production has been focused on aluminum interconnect systems used in demonstrators. Special interest has been given edge roughness of the dray phase patterning method as well as chip to web attachments using adhesives, wire bonding and soldering test cases.

The discussions and material solutions provided by Webshape as resulted in the following publication titles (journals and conference proceedings):

- On the Impact of Edge Roughness to Narrowband and Wideband Flat Dipole Antennas
- On the Influence of Edge Roughness in High-Speed RFID Antenna Manufacturing Processes
- System Integration of Electronic Functions in Smart Packaging Applications
- Modified EAS Tag Used as a Resistive Sensor Platform

Summary - Quality and profiling

An important strategic development has occurred in the project which has formed the basis for the HÖG synergy strategy area called Large Functional Surfaces (LFS) which is a high priority initiative with in the KK program at the Mid-Sweden University. In the ARC13 international peer review evaluation the research work developed within Syspack were regarded as Excellent.

FINAL REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	Low energy CTMP for paperboard
Project leader	Gunilla Pettersson
Ref. no., KKS	20100259
Project time	2011-01-01 --- 2013-12-31

Summary

The project started in January 2011 and has hence been going on for almost 3 years. The goal with the project is to develop and demonstrate a technique, which will make it favourable to use a low energy HTCTMP in manufacturing of multiply paperboard. The total energy consumption in refining of such CTMP should be lower than 600 kWh/ton. The CTMP should principally be added to a middle ply in the paperboard composite and create options for reduction of the grammage at production of a final product quality with certain bending stiffness.

During the project period about 10 project meeting has been held. The companies involved in the project are SCA R&D, SCA Östrand Mill and Stora Enso R&D. Great deals of efforts during past period have been spent on performing pilot plant trials on paper machines and further development of the low energy HTCTMP pulp (High Temperature CTMP) technology at the SCA Östrand mill. With maintained or somewhat improved pulp properties, the electric energy consumption in manufacturing of the HTCTMP was reduced to approximately 600 kW/h in a second mill trial. In the pilot plant trial on the paper machine, Euro FEX at Innventia in Stockholm, the HTCTMP fibres were treated with multilayers of starch and CMC to get high strength in both in and out of plane properties. This is crucial for the low density middle ply of paperboard that is created from HTCTMP. This resulted in more than doubled z-strength and Scott Bond values at a certain sheet density.

Project plan activities

Optimization of the Multilayer Process

Two different strategies to modify the fibre surfaces with polymers were investigated in a laboratory study. Both could improve the out of plane sheet properties (i.e. Z-strength and Scott- Bond) with about 100% at a given sheet density. In-plan sheet properties like tensile index, SCT and stretch-at-break values were all improved as well. Figure 1 below shows results from the laboratory study in the project. It shows how starch/CMC treated CTMP fibers, in comparison with untreated CTMP fibers and CTMP fibres in furnishes with added chemical pulp fibres, gives improved out of plane strength (measured as Z-strength) on paper sheets. When treated HTCTMP fibres are added to a middle layer in a paperboard composite the stiffness is improved, which create options for reduction of grammage in the final product.

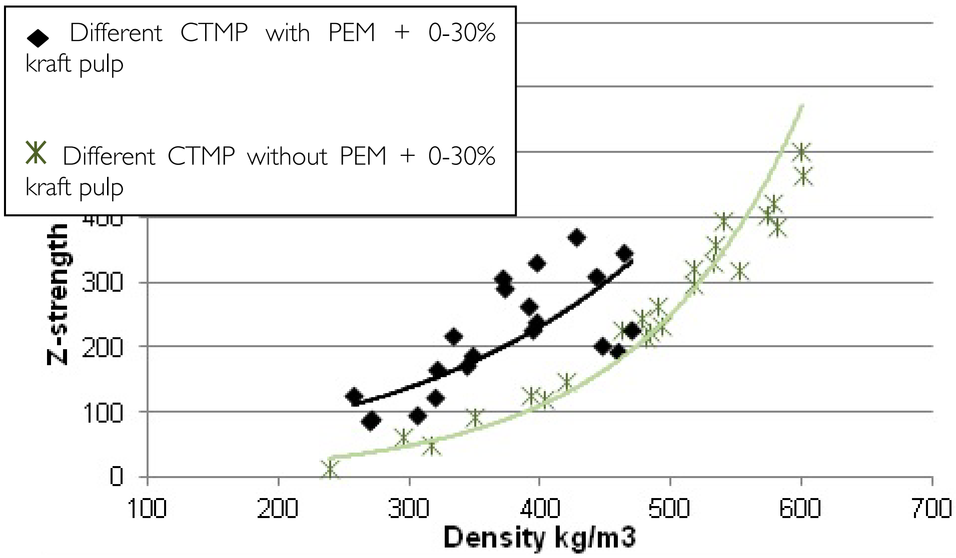


Figure 1 - Z-strength vs. density on sheets for different type of CTMP pulps with different ratio of kraft pulp (KP) and with and without dry strength agents (PEM) on Formette Dynamic sheets.

Pressdrying

The highest strength values value are achieved on sheets, which are dried under pressure up to a final high dryness, fig 2. Using higher temperature during pressing than what is specified in the ISO sheet method gives even better strength, which is a consequence of that the pulps containing native wood lignin (TMP, CTMP). In this project we have shown that using high temperature during the pressing stage gives a huge impact on the strength properties for the pulps treated with starch/CMC in a multilayer. Z-strength can be improved up to 500-600% with these techniques in combination.

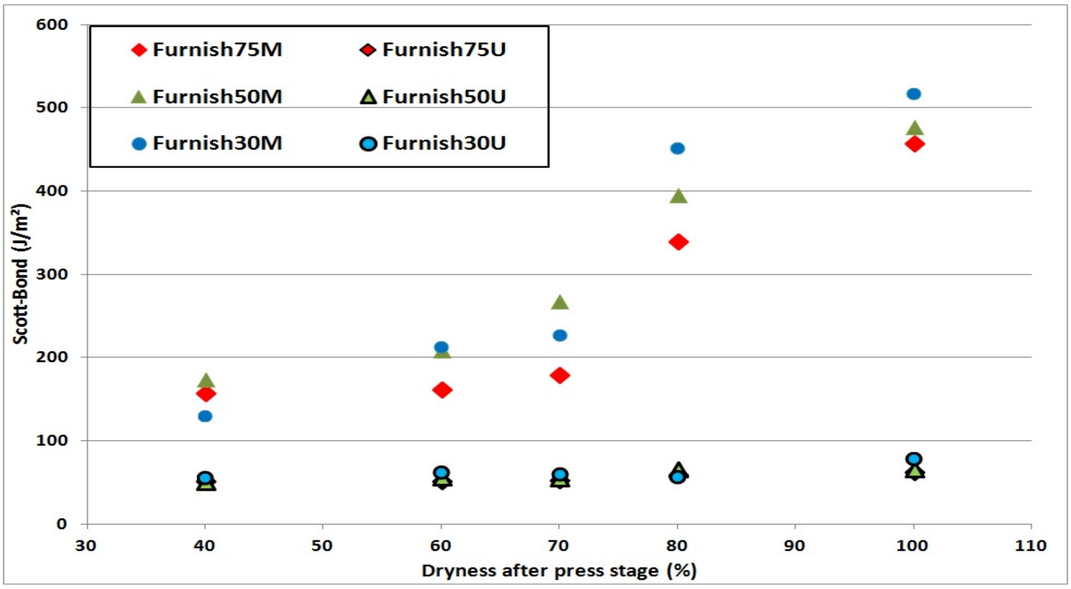


Figure 2 - Strength in sheet Z-direction measured as Scott-Bond value. Drying effects studied at different dryness levels after pressing at high temperature (Rapid Köthen). The figures in the legends specify temperature level during pressing. "U" means that fibres have not been treated with chemicals. "M" means that fibres surfaces have been treated with starch/CMC according to the multilayer technique.

Recent Pilot and Mill Trials

In a second full scale trial at SCA Östrand Mill we succeeded to produce a HTCTMP at quality specification that consumed less than 600 kWh/t in refining energy. The HTCTMP pulp was produced with special types of low energy segments and at higher temperature in the refiner. That pulp showed very good paper board properties in a pilot trial at Innventia pilot paper machine, which has recently been carried out. Fibre treatment with the multilayer technique that was developed in the laboratory studies was tested in this pilot study. The results from the pilot trial are shown in figure 3.

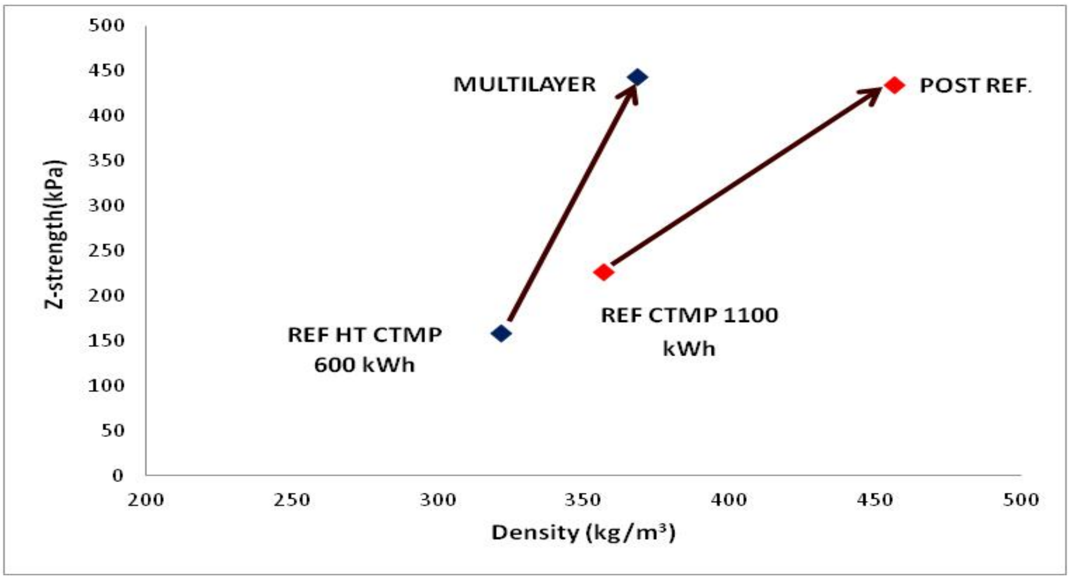


Figure 3. The figure shows results from a pilot trial at EuroFEX at Innventia in Stockholm. Z-strength vs. density on sheets from HTCTMP fibres treated with starch/CMC according to the multilayer technique compared with untreated CTMP that has been post refined in a low consistency stage.

Project achievements

The project has basically shown even better potential compared to what was expected. Partly as it has been able to manufacture a CTMP pulps (HTCTMP) with high quality at energy consumption less than 600 kWh / t at SCA Östrand mill and partly as extensive laboratory studies of these pulps have pave the way for new applications in the future.

Deviations

Two minor changes were made from the original plan of the project. One is that the project was extended for 6 months to realize a pilot trial at Innventia and to finish the report of the pilot trial. This was very much in line with what the participating companies wanted and with the successful result in mind, this was a good decision.

The second change is regarding the academic activity and content. We found very interesting results with pressdrying technique described in this activity report. All the parties agreed on continue this work and the results are of great interest. Sven Norgren who has worked with the pressdrying technique has been added to the project team after the project started. Jessica Sjöberg has worked less than planned in this project due to changes in her employment from Mid Sweden University to SCA R&D Centre.

Co-production

From the perspectives of Stora Enso the results stated above are interesting, since they see an opportunity to save money at the reduction of grammage in production of a final product. Also, they see a possibility to increase the number of customers. The interest for SCA lies in the opportunity to be able to save electric energy in manufacturing of CTMP. From the Mid Sweden University point of view, this project is interesting both since the topic is interesting when it comes to learn more about processes in the industry and application of academic research, but also since it is a part of one of the Mid Sweden University's stated areas of interest.

The overall management of the project has been managed by a steering group with representatives from the participating companies and from the Mid Sweden University. Early in the project, different skills and areas of expertise were identified and those have been exploited to a high degree. This goes in particular both for the mill trials and the pilot trial at Innventia.

Quality and profiling

Research in this project has shown that fibre-fibre bonding potential in sheets from CTMP as well as sheet densification is closely connected to the pressing strategy during papermaking in a totally different way compared to when chemical pulp is used. The basic understanding of this would be interesting in the future to study in detail especially with regard to new cardboard products.

It is also of future interest to combine the three different technologies; i.e. using low energy HTCTMP that is modified according to the developed multilayer technology and pressing technique, to both save energy and create entirely new products that can be used in the paper industry.

From this project, two papers have been accepted for presentation at IMPC 2014 in Helsinki; one oral presentation regarding low energy HTCTMP treated with multilayer and one oral presentation regarding pressdrying. IMPC (International Mechanical Pulping Conference) is the most important international conference in mechanical pulping.

ACTIVITY REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	Ökad energieffektivitet vid mekanisk massaframställning genom modifiering av flisningsprocessen
Project leader	Per Gradin
Ref. no., KKS	20100178
Project time	2011-01-01 --- 2014-03-31
Report period	2013-01-01—2013-12-31

Scientific results

Due to a three months delay with the start of the project, it will end in march 31, 2014. This has been cleared with the KK – foundation. The main scientific result this far (in addition, at least two scientific publications are to appear in the near future) is related to the theoretical modeling of the damage evolution in a wood chip and the definition of a relevant damage parameter. The results from this work was then used when process parameters for large wood chip production were determined. From the companies perspectives, this has been a successful project since e.g. SCA have seen that it is possible to, not only in pilot trials, but also in large scale factory trials, save energy in the production of mechanical pulp. For another participating company, Andritz Iggesund Tools, the project has given them a possibility to enlarge their product portfolio, by a new type of chipping tool (knife).

Apart from the late start of the project (touched on above) the project evolves roughly according to the time plan. Some pilot trials on making CTMP (chemical – thermo - mechanical pulp) out of hard wood (birch) is currently being performed, the results from which will be reported before the end of the project.

Co-production process

From the perspectives of Andritz Iggesund Tools the results stated above are interesting since they see an opportunity to enlarge their product portfolio. Also, they see a possibility to increase the number of customers. St Gobain Abrasives are subcontractors to Andritz Iggesund Tool such that (simply put) what is good for Iggesund Tools is good for them. The interest for SCA lies in the opportunity to be able to save energy. For example, SCA Ortviken consumes some 1500 kWh per ton mechanical pulp. The annual production at Ortviken of mechanical pulp is some 600000 tons and if the use of modified chips can save say 100 kWh per ton and they pay 0.3 SEK per kWh, then they would save some 18 million SEK per annum on this. From the Mid Sweden University point of view, this project is interesting both since the topic is relatively virgin when it comes to more academic research but also since it is a part of one of the Mid Sweden University's stated areas of interest.

The overall management of the project, has been managed by a steering group with representatives from the participating companies and from the Mid Sweden University. Early in the project, different skills and areas of expertise were identified and those have been exploited to a high degree . This goes in particular for the mill trial.

To summarize, it can be concluded that the cooperation so far has been without any problems what so ever and there is a consensus about the overall goals for the project.

Scientific quality and profiling:

There has until now been one journal article published. The journal was Holzforschung which is considered to be one of the best in the pulp and paper science area. The article was quite theoretical in its nature and attempted to quantify the amount of damage introduced into a wood chip due to a cutting process. This is to our knowledge, a novel approach and admits one to perform parameter studies to get a, at least qualitative, picture of the influence of different process parameters. One article about the characterization (in terms of mechanical performance) is to be published soon as is one article about the influence of a particular process parameter.

ACTIVITY REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	ORESS – On-Rotor Embedded Sensor Systems for rotor-dynamics measurements
Project leader	Bengt Oelmann
Ref. no., KKS	20100261
Project time	2011-04-01—2014-03-31
Report period	2013-01-01—2013-12-31

Scientific results

Stator-Free Low Angular Speed RPM Sensor

This work demonstrates the implementation and tests the performance of a low angular speed sensor for rotary machinery based on a Microelectromechanical System (MEMS) gyroscope. Firstly, an experimental test setup has been developed that features a top-of-the-line optical absolute angle encoder as a reference for characterizing the proposed sensor in a controlled environment chamber. A prototype of the proposed sensor has been designed and implemented with its architecture and hardware design described in detail. For experimental purposes, a wireless synchronization scheme between the reference sensor and the gyroscopic sensor has also been developed. Experimental measurement has taken place in order to benchmark the performance of the realized sensor. Experimental data has been processed, analyzed, and the results have been presented. The gyroscopic sensor has shown satisfactory results. The sensor has an accuracy of 0.06 °/s, standard deviation of 0.45 °/s, and hysteresis of 0.08 °/s.

The work has been accepted for publication in IEEE Transactions on Instrumentation and Measurements.

A Comparative Study of Methods for Low Angular Speed Sensing

There are several methods, based on different physical principles, for measuring angular speed. In this work we are investigating these different methods' properties when it comes to low angular speed sensing. The different methods under investigation are:

- Optical Encoder
- MEMS Gyroscope
- Giant Magneto-Resistive Encoder
- Fiber-Optical Gyroscope

The performances of the different methods will be analyzed based on experimental data. This work is in progress where the experimental setup is in place and experimental data is currently collected.

The results are planned to be published in either IEEE Transactions on Instrumentation and Measurements OR IEEE Sensors.

Performance of a Calibrated MEMS-based Angular Speed Sensor

MEMS based gyroscopes are relatively sensitive to temperature variations. In this work we are investigating what accuracy can be achieved through temperature calibration. This is a work in progress.

The results are planned to be published in a conference proceedings.

Results from both the academic and companies' perspectives

At the start-up meeting with the project members, the project was narrowed down sensing methods for low angular speed sensing. The topics left out were wireless power supply and low-power embedded processing. The left-out topics has been addressed in master thesis projects and that has been accepted by all partners. Otherwise there has not been any changes to the initial project plan.

Co-production process

Joint development of experimental equipment has been the main thing in the co-production with other industrial partners. The work has been according to plan.

Scientific quality and profiling

The scientific quality is ranked as excellent. In perspective to the long-term goals of the KK environment the project has no relevance.

FINAL REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	Faskontrast – Online characterization of coating on paperboard with phase- and energy resolved x-rays
Project leader	Börje Norlin
Ref. no., KKS	20100318
Project time	2011-01-01—2013-12-31

Results

The main goal of this project is to answer the question; are online quality measurements using phase- or energy resolved x-rays possible? This question is answered in a satisfactory way, since the measurement methods developed indicate that both phase contrast measurements and energy resolved measurements are possible methods to measure paperboard quality. From the end user perspective the project results is promising for future developments of measurement methods, since the work indicates a linear relation between the measured isotropic scattering coefficient and the conventional burn out-index as in Figure 1. It is remarkable that this relation can be achieved even without reaching a spatial resolution where the paperboard structure actually can be seen.

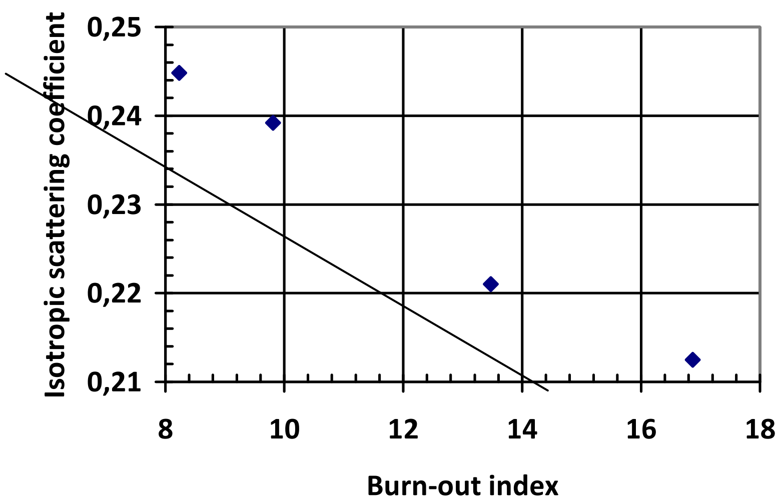


Figure 1 - Relation between phase contrast X-ray measurements and conventional burn-out index of paperboard samples.

In this project, methodology for phase contrast image and data processing as well as software for image blending has been developed. Images of paperboard structures as in Figure 2 are achieved but not yet published. It can be noted that the phase contrast image and the absorption image reveals different information. In Figure 3 a phase contrast image of lichen is shown, verifying that the achieved laboratory setup works as expected.

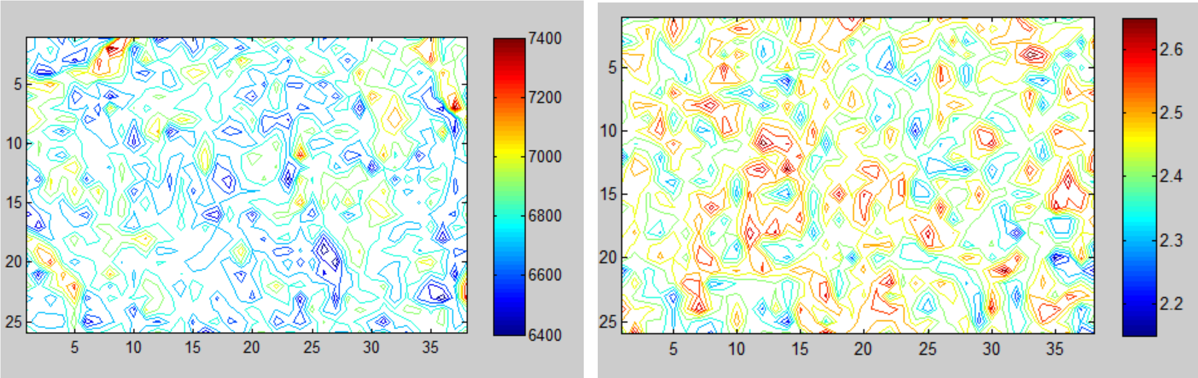
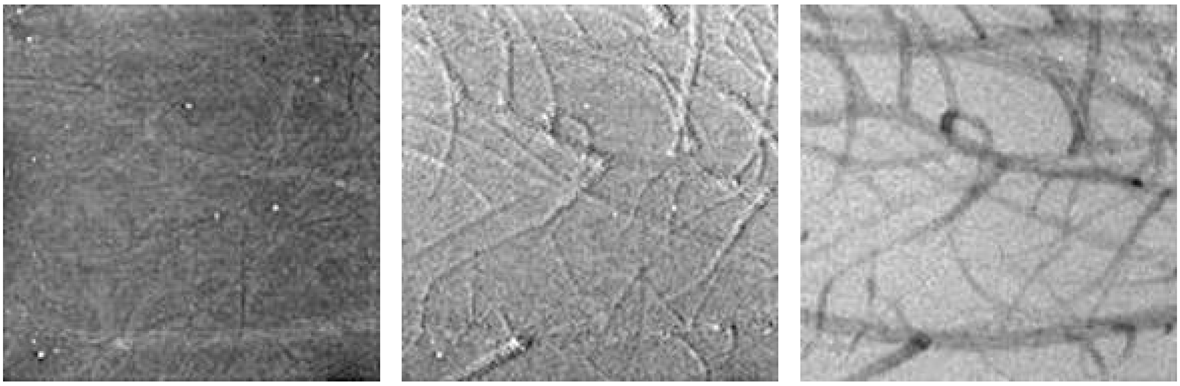


Figure 2 - Contour images of paperboard structure; Left: absorption image, Right: Phase contrast image.

Photography of lichen, Usnea filipendula.



Absorption image Phase contrast image Dark-field image

Figure 3 - Photo and phase contrast images of lichen, demonstrating the enhancement of the standard absorption X-ray image for such a light material sample.

Energy resolved imaging can be used to measure the ration between the core and the coating of paperboard, which also relates to the paperboard quality. General theoretical studies of energy resolved imaging are also reported in research publications. The requirements for specific measurements on paperboard are derived and verified, and the requirements for readout electronics for a proposed system are outlined in a conference paper.

From the main question, a related question arises, is it possible to produce the equipment needed within the industrial framework of the project? Fabrications of gratings are successfully achieved by Acreo Kista. Since the gold plating equipment broke down the gold filling could not be verified, instead a gold grating was bought from Microworks GmbH in Karlsruhe. But Scint-X successfully filled the gratings from Acreo with scintillating CsI. From absorption measurements these gratings are proved to have good uniformity and good filling quality. However, to get reasonable visibility in the phase contrast images, the CsI thickness has to be increased.

Regarding project report deliverables, the theoretical method description from the requirement part of the project is published as a book chapter. One main finding here is that direct conversion in silicon does not give acceptable visibility for the phase contrast method. A detector with scintillating plate or heavier material is needed for this setup. The development of measurement methods constitutes the main part of the project and will be reported in Salim Rezas licentiate thesis, which will contain one phase contrast article and one energy resolving imaging article. Salim Reza was employed as PhD student in November 2011 and later joined the project. The last project tasks about analyze of implementation have not been totally fulfilled, since the project was delayed due to the problem with gold plating equipment. But although no report about implementation of a final product has been written, the issue has been thorough discussed among collaboration the companies. To buy gratings from Microworks is probably too expensive for commercialization. But MidDec Scandinavia has explored the possibility of hiring gold plating facilities in Sweden, and estimates that they can produce gratings to a cheaper production cost. The end user opinion is that for the method to be commercialized, more measurements on "weird" test samples are needed, to stress the method boundaries. A publication on online X-ray imaging limitations is planned to be ready this year. The conclusion is that this implementation task has not failed; instead it is possible to resume and continue the work within this collaboration framework form the point where this project ends.

Laboratory resources for phase contrast X-ray imaging have been established at Mid Sweden University; hence it is possible to continue the research work after the project by studying different paperboard samples or other samples in future research projects or student works.

Co-production

Initially the representatives from Iggesunds eagerly explained the concept concerning paper quality and discussed the physics relating to relevant X-ray measurements. Iggesund provided paperboard test samples of different quality which have been used in the first publications in the project, and also contributed to the paper knowledge in the publications. Mantex contributed to the discussing using their experience from their product "Flow Scanner" which measures moister in wood chips using X-ray technology. Different possibilities in improving Mantex present products using energy resolved results within this project has also been discussed.

Silicon structures were fabricated by Acreo according to MIUN specifications. Absorption gratings could not be delivered since the gold plating equipment broke down. Different alternatives were discussed on several occasions; one was filling the structures with indium, this alternative is still interesting for Scint-X and Mid Sweden University. MidDec Scandinavia has explored the possibility of hiring gold plating facilities in Sweden, or perhaps lead plating. Silicon structures for absorption gratings were delivered by Acreo to Scint-X for filling with CsI. The filled structures were characterized by Scint-X and by MIUN independently and the achieved good quality measures agree.

At Mid Sweden University a 2 meter long lead box for X-ray measurements must be removed to save laboratory space. That coincided well with an identified need from Scint-X to get a lead box of this size for test activities in their new production facility which they had recently moved in to. Scint-X inherited the lead box and started to use it in their production. This is a nice example on collaboration concerning laborative infrastructure between academy and companies.

Iggesund suggests more measurements after the end of the project, perhaps as student work, to get more measurement to verify the correlation achieved, and to also test "weird" samples, to stress the boundaries of the method.

Quality and profiling

One of the products of this project is a licentiate thesis by Salim Reza; in this sense the project is a scientific success. Salim Reza has also visited the University of Erlangen in one week to participate in their studies of phase contrast applications. It was decided to strive for collaboration between our two universities in this subject, since a broadening of the application will gain the theoretical work for both of us. They mainly focus on phase contrast for medical applications and collaborate mainly with Siemens medical. After the delivery of gratings, the first phase resolving results from our setup were achieved using the imaging system at University of Erlangen, as a joint publication. Salim Reza also attended a phase contrast workshop at the royal society in London 11 February 2013. Peter Norlin from Acreo has shown the processing of gratings at two Swedish workshops. So far three journal articles have been produced, and more are planned to be written utilizing project results. One 15 hp student thesis has also been achieved during this time.

Measurement of paperboard quality in this project is targeting effective industrial processes and real time process interaction. Hence this project has contributed to the central long term goals of the KK environment.

In addition to the articles produced during the project, two more articles commenced in the project are planned to be published during 2014.

[1] Jan Thim et al., "X-ray imaging of moving objects using pixel detector systems: Theoretical limits", to be submitted autumn 2014.

[2] Salim Reza et al., "Relation between phase contrast images of paperboard structures and burnout samples", to be submitted autumn 2014.

ACTIVITY REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	COINS – Coexistence and Interference Avoidance for Industrial Wireless Applications
Project leader	Tingting Zhang
Ref. no., KKS	20100258
Project time	2011-04-01—2014-03-31
Report period	2013-01-01—2013-12-31

COINS is a research project on industrial IT. The 3 years in the three years project has soon reached the end. Our research has been focus on studying the problem of radio interference and sharing of limited radio spectrum in 2.4 GHz ISM in industry environment. We have address research problems in the area of coexistence in harsh industrial environments, such as multi-network modeling, interference mitigation techniques, new interference avoidance methods, cross-layer optimization and differentiation service. The academic research aims also to developing solutions for the industry problems.

Literature survey: We started COINS project by an updated literature survey about current industrial standards, academic work and available simulation tools. The results of the activities were included in the related work part in our published articles. This activity finished 2011-09-01.

Test-Bed: We developed a test-bed of WSAN for industrial applications. MIUN and Shortlink did experimental test in real industry environment, such as Stora Enso. The experimental test result has been used in development of interference models in industrial radio environment and cross layer optimization design for industrial WSAN networks**.** Two Master thesis's about the test-bed has been completed. This activity is mainly done by MIUN, ShortLink and ABB. The activity finished 2013-06-10.

Interference modeling: We approached the development of interference model in industrial radio environment through analyzing the real transmission in industry environment. The collected bit-error tracing industrial environment by the test bed was evaluated and results a publication with ABB on IEEE transaction. In this paper, we published the first comprehensive bit-and symbol-level analysis of IEEE 802.15.4 transmission errors in industrial environments. This paper extracted the error properties relevant for future improvements of wireless communication reliability and coexistence of radio systems in these harsh conditions. Our analysis shows that errors inflicted by multipath fading and attenuation exhibit different properties than those imposed by IEEE 802.11 interference.

Coexistence: We studied channel coding and TDMA from industry environment perspective. Several joint publications with ABB about channel coding for hash industrial environment published in industry conferences. In one paper, we did the first performance analysis on real error traces with sufficiently lightweight channel codes, with respect to IEEE 802.15.4-2006 and industrial wireless communication timing constraints. Based on these constraints and bit error properties from the activity 2, the use of Reed-Solomon (15,7) block code is suggested, which can be implemented in software. Experiments show that bit error nature on links affected by multipath fading and attenuation in industrial environments is such that RS(15,7) can correct 95% of erroneously received packets, without the necessity for interleaving. On links under IEEE 802.11 interference, typically up to 50% of corrupted packets can be recovered by combining RS(15,7) with symbol interleaving, which has proven to be more effective than its bit counterpart. The optimal interleaving depth is found empirically and it is shown that simple bit-interleaved 1/3 repetition code achieves at least 90% of correcting performance of RS(15,7) code on uninterfered links that operate 10 dB above the sensitivity threshold.

Cross layer optimization: Time division multiple access (TDMA) is a prominent access method for shared channels in industrial wireless sensor networks with their strict timing requirements. Each sensor receives a number of recurring timeslots for packet transmission with the advantage being that multiple nodes can transmit concurrently if the physical properties of the network preclude interference. Scheduling algorithms for the assignment of sensors to timeslots under quality of service (QoS) guarantees such as throughput, delay, or fairness, are required. We proposed several cross layer algorithm of TDMA scheduling.

Existing TDMA scheduling algorithms has not investigated the adaption to the dynamics of a realistic wireless sensor network in a satisfactory manner. This is a key issue considering the challenges within industrial applications for wireless sensor networks, given the time-constraints and harsh environments. In response to those challenges, we published SAS-TDMA, a joint publication with ABB. It is a cross-layer solution which adapts itself to network dynamics. It realizes a trade-off between scheduling length and its configurational overhead incurred by rapid responses to routes changes. We implemented a TDMA stack instead of the default CSMA stack and introduced a cross-layer for scheduling in TOSSIM, the TinyOS simulator. Numerical results show that SAS-TDMA improves the quality of service for the entire network.

We also proposed optTDMA, a novel cross layer algorithm for end-to-end packet delivery rate optimization in TDMA-based wireless sensor networks, together with a scalable measure for schedule quality assessment, have been proposed. To our knowledge, this is the first study utilizing a stochastic model for TDMA schedule optimization.

Network managers: In managing network to have reliable and real-Time Wireless Fieldbus Communication in interference environments, a vital issue of guaranteeing time delivery for emergency traffic has to be addressed. Exceeding the required delay bound for unpredictable and emergency traffic could lead to system instability, economic and material losses, system failure and, ultimately, a threat to human safety. However, guaranteeing the timely delivery of the critical traffic and its prioritization over regular traffic is a significant challenge. We proposed Priority-MAC, a Priority enhanced MAC protocol, designed for critical traffic in Industrial wireless sensor network, and the first priority enhanced MAC protocol compatible with IWSAN industrial standards. The Priority-MAC was extended to the network layer by means of the joint delay bounded routing and the PriorityMAC, designed for routing critical traffic in industry wireless sensor network. PriorityMAC achieves a significant reduction regarding the latency in experimental evaluation and theoretical analysis.

Understanding the traffic load distribution can guide the network-wide energy allocation, the design of routing algorithms, and the optimization of the node deployment in WSNs. The character of traffic load of wireless sensor network has investigated in a paper.

Wireless multi-networks management: The investigation of multi wireless network management has investigated in several aspects. A technical paper of quickly detecting WIFI interference has finished. The proposed methodology has been implemented and will be tested in real industrial environment.

Co-production process

ABB and Shortlink has deeply involved in the project. The regular personal/ telephone meetings were established in the three years. 10 of our 14 the publications are joint publications of MIUN and ABB. Shortlink did most valuable contribution in measurements and experimental testing. Through the project, ABB, Shortlink and MIUN have found other interested projects and want to further cooperated in the wireless sensor network area.

Scientific quality and profiling:

The result of the project reaches a very high scientific quality goal. The COINS was going to publish least 2 journal papers and several conferences papers. Up to now, we published 5 articles in journals. All of the journals have been classified as top journals and have high impact facts. We have 9 papers in international conferences and workshops, where some of them are well known conferences on networking. The project has also results about 20 master thesis reports. Except the journal and conference papers, one Ph.D student Wei Shen successively defended his thesis of "A Protocol Framework for Adaptive Real-Time Communication in Industrial Wireless Sensor and Actuator Networks", 6 March 2014.

The profiling of the project is in wireless sensor network. It contributes to industry IT and can support many industrial applications, such as automation, quality control, energy efficient, safety and etc. The result of the project can have considerable impacts on increasing reliability of wireless sensor network for industrial environment. A reliable wireless communication is the basic condition of most current and future IT supporting system for industries. A reliable wireless sensor network can create many new industry applications that we are not able to offer today.

ACTIVITY REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project/action	Adjungerad professor – Robust Wireless Communication
Project leader	Mikael Gidlund
Ref. no., KKS	20120330
Project time	2013-04-01—2015-03-31
Report period	2013-04-01—2013-12-31

Scientific results

The project is divided into different work packages (WPs) where the adj. professor is participating in. Below is a short summary of the scientific progress in respectively WPs are given:

WP 1: Wireless Tracking in Harsh Underground Environments
Within this project we have done a survey of state-of-the-art technologies that are currently used for localization and positioning in underground environments. We have also done some RF measurements in underground environments in order to characterize the radio channel in order to design wireless systems in best possible way. The initial measurements reveal that only using WLAN technology will not sufficient due to poor accuracy in position estimates. Therefore we have tested to use Ultra Wideband (UWB) communication technology instead and initial results are interested but further investigations are needed.

WP 2: Coexistence and Interference Avoidance in Industrial Wireless Applications
We have done an extensive RF measurement campaigns in two pulp and paper mills in Sweden and analyzed the huge number of collected data. Our analysis reveals that using received signal strength (RSS) and/or link quality estimator (LQI) to determining if packets are correctly decoded etc are very misleading. Furthermore, from the measurements we can conclude that future wireless sensor networks should include some kind of forward error correction (FEC).

WP 3: Scheduling and aggregation for Wireless Sensor Networks
We are continuing to study different scheduling strategies for real-time communication over wireless sensor networks in industrial automation. Existing systems today are using best effort traffic which may be a nice solution for pure monitoring applications but for control applications prioritization of traffic is needed. We have proposed a prioritized scheduling algorithm suitable for time-critical WSN applications.

WP 4: Wireless Control Applications
During the period we have mainly focused on theoretical studies on deterministic communication for control applications in process automation. These studies are based on a granted patent. Out initial studies show that the proposed concept is suitable for star networks and future research is to investigate mesh network topologies.

WP 5: Investigation of Cognitive Radio for Industrial Automation

So far there have been little activities in this WP due to Mikael Gidlund has focused on other projects (WP1-WP4). The plan is to analyze the large set of collect data we have from several different industrial plants and investigate if some concepts of spectrum sensing can be useful in an industrial automation setting. This work will mainly be done by a master thesis student.

WP 6: Investigation of Network Design for Smart Grids

There has been no activity in this WP yet for two reasons. Firstly, the results in WP1-4 have been very encouraging and therefore ABBs interested has been focused to these WPs. Secondly, we have not found enough skilled MSc thesis students to start the work in this WP.

Co-production process

During this period one PhD student has been visiting researcher at ABB Corporate Research working with implementation of scheduling algorithms in wireless sensor networks. Furthermore, currently there is one MSc thesis student in the area of Coexistence and interference management that is jointly supervised by researchers from ABB Corporate Research and Mid Sweden University. We expect that this work will result in at least one conference publication. During the period several jointly publications between researchers from Mid Sweden University and ABB Corporate Research has been accepted in various distinguished international conferences. We have also collaboration with Beijing Jiatong University in China and Aalborg University in Denmark. Some parts of the achieved results have been used by ABB in their standardization efforts. Furthermore, researchers from ABB Corporate Research have been visiting MIUN to give lectures in the Wireless Internet Access course where the project leader of this project was examiner and main teacher.

Scientific quality and profiling

The conference articles published during the report period are all more or less accepted in the flagship conferences organized by the IEEE Industrial Electronics Society (IES). The project leader is well recognized expert in IES for his work regarding Industrial Wireless Sensor Networks. Furthermore, in the work to promote MIUN as an established University with high class research in the Industrial Electronics society, the project leader has together with researchers from ABB Corporate Research arranged tutorials and special sessions at the IES flagship conferences. Many of the achieved results within this project and KKS-project COINS has been used by ABB in standardization efforts but also been patented. This is a clear indication that the project is so far successful and produces useful results for Swedish industry and creates academic excellence for MIUN.

FINAL REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project	Vätska-substrat växelverkan för tryckteknik: ett nanoperspektiv
Project leader	Petru Niga och Jonas Örtegren
Ref. no., KKS	20120326
Project time	1 jan 2013 – 31 dec 2013

Results

The major scientific results from the project are the following. We have shown that:

- black ink and cyan ink from project partners exhibit the ColorLok® -effect as determined by: i) ink draw down measurements utilizing the specific inks ii) inkjet printing and print density measurements.
- the force field between cyan ink from project partner and i) silica ii) mica, and iii) paper containing only cellulose fiber, in aqueous solutions, can, firstly, be determined, secondly, can be controlled by adding various amounts of salt, and, thirdly, can be controlled by the valency of the salt added.
- the force field between cyan ink nano particles in aqueous solutions is strongly affected by adsorption of polymer electrolyte onto the ink pigments. The force field can furthermore be controlled by adding various amounts of salt, and by the valency of the added salt.
- a mechanism different from the mechanisms described in the ColorLok® patent portfolio can be used to achieve a ColorLok® effect, which, depending on the paper, is as strong or even stronger than the ColorLok® and ColorPro® effects. This is work in progress in collaboration with project partners and concerns decisions on patent filing.

Co-production

The project partners were companies producing paper, packages and board (Stora Enso, SCA, Metsä Board), paper R&D consultancy companies (MoRe Research), ink producing companies (Sensient, Flint Grp) and inkjet machine manufacturers (OCE). With one of the companies (Flint Grp) it came to negotiations concerning the company's contribution to the project. Signing of the contract was therefore delayed. It was decided half way through the project that Flint Grp should make half of the initially suggested contribution to the project. The common contract for all companies to sign was thereafter rewritten, and thereafter sent to the companies together with non-disclosure agreements (NDA). In three cases, signing of contracts involved signing by non-Swedish speaking personnel, and the economic contract and the NDA was translated into English partly by us (we had the NDA translated into English early on in the process), partly by the companies (the economic contract to be signed by all parties is written in Swedish and has to be translated by the companies in accordance with the routines prevailing at the companies). In two cases (OCE and Flint Grp) translation and signing of contracts was not in place when it was decided that the contract should be turned in to the Kk-foundation. Therefore the University decided to cover for the loss of financiation. The economic contract was therefore rewritten and signed by Stora Enso, SCA, Metsä Board, MoRe Research, and Sensient.

Three project meetings and one telephone conference meeting was held. Participants on the meeting were:

- Time and Place: February 28th 2013 at Digital Printing Center at Mid Sweden University in Örnsköldsvik. Participants: Petru Niga, Mid Sweden University, Robert Olsson, SCA, Martial Blanc, Sensient, Pascal Gruffel, Sensient, Kristina Wågberg, Metsä Board, Lydia Kirchhof, OCE, Anna Eriksson, OCE, Olle Högberg, Stora Enso, Jan-Erik Hägglund, MoRe, Jonas Örtegren, Mid Sweden University.
- Time and Place: 11th of June 2013 at Arlanda Airport Conference. Participants: Petru Niga, Mid Sweeden University, Robert Olsson, SCA, Martial Blanc, Sensient, Kristina Wågberg, Metsä Board, Olle Högberg, Stora Enso, Jonas Örtegren, Mid Sweden University.
- Time: 27th of September 2013. Phone Conference Call. Participants: Anders From, SCA, Kristina Wågberg, Metsä Board, Olle Högberg, Stora Enso, Pascal Gruffel, Sensient, Jonas Örtegren, Mid Sweden University, and Petru Niga, Mid Sweden University.
- Time and Place: 5th of December 2013 at Sensient facilities in Switzerland. Participants: Lydia Kirchhoff, OCE, Jerker Jäder, SCA, Kristina Wågberg, Metsä Board, Olle Högberg, StoraEnso, Pascal Gruffel and Martial Blanc, Sensient, Jonas Örtegren and Petru Niga, Mid Sweden University.

The "hands on" work in the project concerned surface treatment of uncoated papers, and usage of uncoated paper with and without surface treatment, and to which the paper companies contributed with materials, skills and knowledge. Ink draw down measurements and parts of the paper testing was performed at Metsä Board. Surface treatment with our own fluid was done using special equipment from MoRe Research. Laboratory paper containing only cellulose fiber was made at MoRe Research. Atomic Force Spectroscopy measurements were partly performed at SCA R&D. Development of special inks with and without adsorbed polymer, and development of nano particle (micro particle) pigments of varying size was done by Sensient. Either specialty inks or specialty paper was provided by all seven companies involved in the project.

We will send in a final financial report as soon as we have got the revised remaining companies report.

Quality and profiling

In the project, research at a high level was combined with more practical development of ideas concerning how to find alternative ways and alternative materials to surface treat paper in order to gain print quality.

The project demonstrates functionalization of paper surfaces and novel usage of printing technologies. The project focuses on gaining knowledge on nano particle interaction with other nano particles, with fibers, and with other surfaces, related to cellulose fiber and paper. These interactions and this knowledge are key issues in the development of the next generation forest products, and are well in line with the profiling efforts at Mid Sweden University. The project is also highly relevant to the printed electronics activities at Mid Sweden University, since functionalization of the surfaces is a key issue for printed electronics.

Upcoming publications

- Assessment of the Force field between color pigments in aqueous solutions containing various salts, P. Niga, et al., Status: work in progress, to be submitted to Colloids and Surfaces A.
- Controlling the Force field and the XXX by YYY for inkjet printing applications, P. Niga, et al., Status: patent filing and market analysis for commercialization is in progress, thereafter the publication will be written and submitted to Colloids and Surfaces A.
- Ink -Media Interaction: Agglomeration Of Color Pigments By Salt With Different Valency And Impact On Print Quality, J. Örtegren, et al., submitted to NIP-30, Philadephia, September 7-11, 2014.
- Hybrid package printing: Assessment of the influence of paper media parameters for inkjet printing on flexographic printed paper, P. Niga et al., www.Flexo.de, Narrow Web Tech 1, pp 16-22, 2014. (Invited paper in a major german printing industry branch journal).

ACTIVITY REPORT

An appendix to the KK-environment monitoring report from Mid Sweden University, spring 2014.

Name of project	PLENOCAP – Plenoptisk infångning och beräkningsbaserad fotografering
Project leader	Roger Olsson
Ref. no., KKS	20120328
Project time	201-04-01—2015-03-31
Report period	2013-04-01—2013-12-31

Scientific results

The project's scientific work has during fall 2013 centered on building a knowledgebase relative to state-of-the-art in plenoptic capture and computational photography. The field, albeit resting on discoveries made in the early 20th century by Ives and Lippmann, is still in its infancy with respect to a stable and consistent terminology, and a clearly defined evaluation and analysis methodology that allows for explicit and direct comparison of result in terms of both quality as well as computational efficiency. Plenocap has, as intended, set out to address these aspects.

Firstly by gathering tools necessary for approaching the problem. More explicitly in the form of an investigation of applicable optical simulation software tools that was conducted during the fall 2013. The investigation resulted in defining two strategies to follow within the rest of the project: 1) the purchase of the state-of-the-art generic optical simulation software Zemax, and 2) the development of a specific plenoptic simulation software based on the real-time raytracing framework Optix from Nvidia. The two strategies both share the same aim to be integrated with the already present MATLAB environment, which is available to the project and has been thoroughly used throughout previous research activities.

Secondly, the terminology and methodology aspects have been addressed in the form of a pre-study targeting a journal paper that surveys the plenoptic field and identifies areas of improvements and future work with respect to the above mentioned shortcomings.

In parallel to the above two activities research efforts have been pursued to validate the previously proposed plenoptic model Sampling Pattern Cube (SPC) relative to the commercially available plenoptic camera from Lytro. The validation was successful. In addition, an enhancement to the state-of-the-art High Efficiency Video Coding (HEVC) standard was made that enhance the resulting compression efficiency when HEVC is applied as a compression method for plenoptic images. The compression efficiency was improved relative to related work. The result from these two parallel activities was submitted to, and accepted for presentation, at the 2014 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP). The title of the papers are "Performance Analysis in Lytro Camera: Empirical and Model Based Approaches to Assess Refocusing Quality" and "Efficient Intra Prediction Scheme for Light Field Image Compression" respectively.

The project is in-line with its external scientific publication goals. Some of the planned internal documentation milestones have been postponed a few months in order to incorporate the results from the two activities mentioned above.

Co-production process

The first part of the project was defined to in part consist of spreading information about the field of plenoptics to the participating companies and identifying explicitly how this emerging field, and its applications, could be leveraged with the competence present in the industrial partners. This has been addressed using a project kick-off where an introduction to the field of plenoptic capture was made, followed up my project meetings where news within the project and within the research field is shared. In accordance with the project plan the co-production will ramp up during first half of 2014, with more explicit research and development activities in collaboration with partner companies.

Scientific quality and profiling

The Plenocap project activities relate to the two prioritized areas defined in the KK-environment: "Sensor based systems and services for a sustainable society" and "Industrial IT for development of an efficient and sustainable industry". The explicit goal of the KK-environment to "increase the percentage of articles published in journals of higher quality" is addressed by disseminating the initial research of Plenocap in a journal publication in the form of a broad survey paper. The co-production activities already defined for the project partners in the project plan is directly in line with the KK-environment goal of "To develop the forms of co-production both in terms of deepening relationships with existing partners and expanded relationships with new competence clusters and application areas.". During fall 2013 there has also been explicit activities to identify new partners in order to form a Swedish competence cluster within the field of plenoptics. The companies contacted have other application areas in mind than those addressed within Plenocap.

Appendix E – Economic report of KK Action

KK-miljö, Ekonomisk redovisning (årlig)

Projektnamn	KK-miljö 2013, finansiering KKS, total sammanställning
Projekthuvudman	Anders Söderholm
Lärosäte	Mittuniversitetet
Projekttid	År 2012-2021

Finansiering från KK-stiftelsen **1.1 Lönekostnader, inkl påslag, per åtgärd**	**Bokförda kostnader**
e2mp - rp	4 763 568
STC Industriell IT	3 141 057
SysPack	906 000
CTMP för kartong	2 429 906
Modifiering av flisningsprocessen	738 066
ORESS	679 987
Faskontrast	956 429
COINS	857 122
Robust Wireless Communication	-
Vätska-substrat växelverkan för tryckteknik: ett nanoperspektiv	418 216
PlenoCap	473 793
Total lönekostnad, exkl. lärosätesoverhead	15 364 144
Overhead	6 145 658
Total lönekostnad inkl. lärosätesoverhead	21 509 802
Övriga kostnader	
Utrustning	219 797
Material	298 098
Resor	808 394
Lokaler	1 176 401
Övriga kostnader	582 208
Totalt övriga kostnader	3 084 898
Total kostnad inkl. lärosätesoverhead	24 594 700

Financial Outcome

Project Name:	e2mp-rp, Industriinitiativ energieffektiv tillverkning av mekanisk massa
Project Leader:	Per Engstrand
Project Time:	2011-04-01 ---2017-03-31

e2mp-rp	**Final costs**							
	2011		**2012**		**2013**		**2011-2013**	
	KKS	MIUN	KKS	MIUN	KKS	MIUN	Companies*	**Total**
Salary costs	855 487	1 098 150	4 692 971	2 309 472	4 763 568	1 980 886	12 135 030	**27 835 564**
Premises costs	90 005	80 196	585 334	138 147	560 589	89 000	0	**1 543 271**
Travel costs	127 058		296 571		341 779		742 333	**1 507 741**
Material costs	20 581		102 618		75 386		1 309 950	**1 508 535**
Other costs								
Equipment costs	*29 463*	*265 018*	*99 354*		*20 122*		*375 954*	**789 911**
Costs of communicating the results	*24 144*		*70 114*		*49 898*		*0*	**144 156**
Consult costs	*31 888*						*3 013 859*	**3 045 747**
Total, other costs	85 495	265 018	169 468	0	70 019	0	3 389 813	**3 979 813**
Overhead costs	342 195		1 877 188		1 905 427		0	**4 124 810**
Total per financier	**1 520 821**	**1 443 364**	**7 724 150**	**2 447 619**	**7 716 768**	**2 069 886**		
Total project		**2 964 185**		**10 171 769**		**9 786 654**	**17 577 126**	**40 499 734**

	*** Specification of companies costs**							
	2011 - 2013							
	Andritz	Holmen	Metso Paper	SCA R&D	Stora Enso			**Total**
Salary costs	1 899 030	4 201 600	914 800	1 613 600	3 506 000			**12 135 030**
Premises costs								**0**
Travel costs	167 126	250 096	61 517	15 000	248 594			**742 333**
Material costs		438 261	859 689		12 000			**1 309 950**
Other costs								
Equipment costs		*340 000*	*2 618*	*32 500*	*836*			**375 954**
Costs of communicating the results								**0**
Consult costs	*567 010*	*402 014*		*1 704 354*	*340 481*			**3 013 859**
Total, other costs	567 010	742 014	2 618	1 736 854	341 317			**3 389 813**
Overhead costs								**0**
Total per financier	**2 633 166**	**5 631 971**	**1 838 624**	**3 365 454**	**4 107 911**			

	According to agreement							
	2011		**2012**		**2013**		**2011-2013**	
	KKS	MIUN	KKS	MIUN	KKS	MIUN	Companies*	**Total**
Salary costs	2 728 543	1 450 042	3 739 055	1 559 028	4 069 541	1 657 274	11 304 000	**26 507 483**
Premises costs	424 501	101 439	594 243	140 556	615 064	139 230		**2 015 033**
Travel costs	204 641	47 218	280 429	51 429	305 216	61 531	720 000	**1 670 464**
Material costs	48 702	66 884	35 071	41 498	53 463	23 661	1 656 000	**1 925 279**
Other costs								
Equipment costs	*194 809*	*300 975*	*144 283*	*186 740*	*213 852*	*106 474*	*3 240 000*	**4 387 133**
Costs of communicating the results	*48 702*	*33 442*	*36 071*	*20 749*	*53 463*	*11 830*		**204 257**
Consult costs	*0*						*1 080 000*	**1 080 000**
Total, other costs	243 511	334 417	180 354	207 489	267 315	118 304	4 320 000	**5 671 390**
Overhead costs	1 091 417		1 495 622		1 627 816			**4 214 855**
								0
Total per financier	**4 741 315**	**2 000 000**	**6 324 774**	**2 000 000**	**6 938 415**	**2 000 000**	**18 000 000**	
Total project		**6 741 315**		**8 324 774**		**8 938 415**	**18 000 000**	**42 004 504**

Financial Outcome

Project name:	Forskningsprofil+, STC Industriell IT
Project leader	Mattias O'Nils
Project time	2011-10-01--2013-09-30

STC Industriell IT	**Final costs**					
	Year**					
	1		2			
	KKS	MIUN	KKS	MIUN	Companies 2011-2013*	Total
Salary costs	2 994 758	3 644 486	3 141 057	2 512 681	7 626 615	19 919 597
Premises costs	297 859	251 929	186 598	213 578		949 964
Travel costs	53 491		139 542			193 034
Material costs	241 064	203 236	167 698	147 484	125 000	884 482
Other costs						
Equipment costs	32 899		78 745			111 644
Costs of communicating the results	205 962		21 016			226 978
Consult costs						0
Total, other costs	*238 861*		*99 761*			*338 622*
Overhead costs	1 158 002		1 296 324			2 454 326
Total per financier	**4 984 035**	**4 099 651**	**5 030 981**	**2 873 743**		
Total project		**9 083 686**		**7 904 724**	**7 751 615**	**24 740 025**

**Year 1 = 2011-10-01--2012-12-31, 15 month out of 24

	*** Specification of companies costs**								
	2011 - 2013								
	SenseAir	ABB Corp. Reserach	SCA R&D Centre	Combitech	RTI	SiTek	Gunnebo Gateway	VisualEyes	**Total**
Salary costs	1 793 600	2 047 767	320 000	1 459 600	1 100 000	892 648	13 000	0	**7 626 615**
Premises costs									**0**
Travel costs									**0**
Material costs			80 000		40 000		5 000		**125 000**
Other costs									**0**
Equipment costs									**0**
Costs of communicating the results									**0**
Consult costs									**0**
Total, other costs	0	0	0	0	0	0	0	0	**0**
Overhead costs									
Total per financier	**1 793 600**	**2 047 767**	**400 000**	**1 459 600**	**1 140 000**	**892 648**	**18 000**	**0**	**7 751 615**

	According to agreement					
	Year					Total
	1		2			
	KKS	MIUN	KKS	MIUN	Companies*	
Salary costs	2 789 000	3 092 000	2 929 000	3 021 000	7 570 000	19 401 000
Premises costs	334 800	225 410	348 059	225 410		1 133 679
Travel costs	200 000		200 000			400 000
Material costs	265 000	175 000	246 941	175 000	130 000	991 941
Other costs						
Equipment costs	130 000		10 000			140 000
Costs of communicating the results	130 000		130 000			260 000
Consult costs	0		0			0
Total, other costs	*260 000*		*140 000*			*400 000*
Overhead costs	1 115 600		1 171 600			2 287 200
Total per financier	**4 964 400**	**3 492 410**	**5 035 600**	**3 421 410**		
Total project		**8 456 810**		**8 457 010**	**7 700 000**	**24 613 820**

Ekonomisk redovisning (slutlig) - HÖG 10

Diarienummer	20100263
Projektnamn	SysPack
Projektledare	Hans-Erik Nilsson
Lärosäte	Mittuniversitetet
Projekttid	20110101-20131231

Bidrag KK-stiftelsen

	Bokförda intäkter
Bidrag från KK-stiftelsen	4 796 000

Bidrag Företag

SCA R&D Center	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid	3003,5	800	2 402 800
Interna resurser: anv. av dyrbar utr.			
Totalt bidrag			2 402 800

Sweprod AB	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid			900 000
Interna resurser: anv. av dyrbar utr.			
Totalt bidrag			900 000

DP Patterning AB (tidigare Webshape)	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid			100 000
Interna resurser: anv. av dyrbar utr.			50 000
Totalt bidrag			150 000

Oregon Scientific	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid			
Interna resurser: anv. av dyrbar utr.			1 500 000
Totalt bidrag			1 500 000

Kostnader

Typ av kostnader		Bokförda kostnader
Lönekostnader (inkl. sociala avgifter peranställd)		
Hans-Erik Nilsson		327 282
Henrik Andersson		761 999
Anatoly Manuilskiy		192 438
Håkan Olin		317 641
Sverker Edvardsson		1 118 731
Renyun Zhang		480 551
OH-pålägg	40%	1 280 086
Total lönekostnad inkl OH		4 478 728

Utrustning	3 836
Material	49 039
Resor	54 283
Lokaler	187 541
Övriga kostnader	22 633
Totalt kostnader i kkr	4 796 060

Observera: Till den ekonomiska rapporteringen ska intyg om medfinansiering från de deltagande företagen bifogas.

Ekonomisk redovisning (slutlig) - HÖG 10

Diarienummer	20100259
Projektnamn	Låg energi CTMP för kartong
Projektledare	Gunilla Pettersson
Lärosäte	Mittuniversitetet
Projekttid	2011-01-01 --- 2013-12-31

Bidrag KK-stiftelsen

	Bokförda intäkter
Bidrag från KK-stiftelsen	**4 260 000**

Bidrag Företag

SCA R & D Centre	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	1 144	950	1 086 800
Interna resurser: anv. av dyrbar utr.			653 630
Totalt bidrag			**1 740 430**

Stora Enso	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	3 456	850	2 937 175
Interna resurser: anv. av dyrbar utr.			319 588
Totalt bidrag			**3 256 763**

Kostnader Mittuniversitetet

Typ av kostnader		**Bokförda kostnader**
Lönekostnader (inkl. sociala avgifter per anställd)		
Per Engstrand, Professor		66 997
Sven Norgren, Forskningsingenjör		661 708
Gunilla Pettersson, Forskningsingenjör		1 393 747
Hans Höglund, Senior Professor		161 825
Max Lundström, Forskningsingenjör		61 807
Staffan Nyström, Ingenjör		83 823
OH-pålägg	40,00%	
Total lönekostnad		3 401 869
Utrustning		4 020
Material		55 786
Resor		211 128
Lokaler		169 165
Övriga kostnader		418 032
Totalt kostnader i kkr		**4 260 000**

Observera: Till den ekonomiska rapporteringen ska intyg om medfinansiering från de deltagande företagen bifogas.

HÖG 10 Ekonomisk redovisning (årlig)

Diarienummer	20100178
Projektnamn	Ökad Energieffektivitet vid Mekanisk Massaframställning genom Modifiering av Flisningspr
Projekthuvudman	Mittuniversitetet
Adress	851 70 Sundsvall
Organisationsnummer	202100-4524
Stödbelopp	4200000
Projekttid	2011-01-01 - 2014-03-31 (förlängt)

Kostnader aktuellt år

Finansiering från KK-stiftelsen		
1.1 Lönekostnader, inkl. påslag		
Namn	Position	Bokförda kostnader
Torbjörn Carlberg	Professor	175 078
Per Gradin	Professor	188 455
Lisbeth Hellström	Biträdande lektor	305 683
Staffan Nyström	Ingenjör	56 524
Max Lundström	Forskningsingenjör	12 327
Total lönekostnad, exkl. lärosätesoverhead		738 066
Overhead	40,0%	
Total lönekostnad, inkl. lärosätesoverhead		1 033 293
Övriga kostnader		
1.2 Kostnad för utrustning		
1.3 Materialkostnad		14 107
1.4 Resekostnader		2 045
1.4 Lokalkostnader		38 533
1.6 Övrigt		66 608
Total övriga kostnad		121 293
Total kostnad inkl. lärosätesoverhead		1 154 586

Underskrift av redovisningsansvarig

Underskrift projektledare

Namnförtydligande

Namnförtydligande

HÖG 10 Ekonomisk redovisning (årlig)

Diarienummer	20100261*
Projektnamn	ORESS-Inbyggda sensorsystem på rotor
Projekthuvudman	Mittuniversitetet
Adress	Holmgatan 10
Organisationsnummer	202100-4524
Stödbelopp	2 876 600
Projekttid	20130101-20131231

Kostnader aktuellt år

Finansiering från KK-stiftelsen

1.1 Lönekostnader, inkl. påslag

Namn	Position	Bokförda kostnader
Cheng Peng		533 303
Bengt Oelmann		146 683
Total lönekostnad, exkl. lärosätesoverhead		679 987
Overhead	40,0%	
Total lönekostnad, inkl. lärosätesoverhead		951 982
Övriga kostnader		
1.2 Kostnad för utrustning		
1.3 Materialkostnad		-73 617
1.4 Resekostnader		
1.4 Lokalkostnader		37 065
1.6 Övrigt		
Total övriga kostnad		**-36 552**
Total kostnad inkl. lärosätesoverhead		**915 429**

Underskrift av redovisningsansvarig

Underskrift projektledare

Namnförtydligande

Namnförtydligande

Ekonomisk redovisning (slutlig) - HÖG 10

Diarienummer	20100264
Projektnamn	Faskontrast
Projektledare	Börje Norlin
Lärosäte	Mittuniversitetet
Projekttid	2011-01-01 - 2013-12-31

Bidrag KK-stiftelsen

	Bokförda intäkter
Bidrag från KK-stiftelsen	-3 896 000

Bidrag Företag

Iggesund Holmen Group	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid			1 445 000
Interna resurser: anv. av dyrbar utr.			6 000
Totalt bidrag			1 451 000

Mantex AB	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid	1 530	800	1 224 000
Interna resurser: anv. av dyrbar utr.			
Totalt bidrag			

Scint-X AB	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid	1 667	600	1 000 200
Interna resurser: anv. av dyrbar utr.			
Totalt bidrag			1 000 200

MidDec Scandinavia AB	*Antal tim*	*kr/tim*	*Totalt kkr*
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid	543	600	325 800
Interna resurser: anv. av dyrbar utr.			
Totalt bidrag			325 800

Kostnader

Typ av kostnader		Bokförda kostnader
Lönekostnader (inkl. sociala avgifter peranställd)		
Christer Fröjdh		678 883
Göran Thungström		579 969
Börje Norlin		800 340
Reza Salim		87 980
Esebamen Omeime		69 864
Mattsson Claes		6 889
Lundgren Thim Jan		373 724
OH-pålägg	40%	1 039 125

Total lönekostnad	3 636 774
Utrustning	4 699
Material	17 262
Resor	45 730
Lokaler	145 929
Övriga kostnader	45 812
Totalt kostnader i kkr	3 896 206

Observera: Till den ekonomiska rapporteringen ska intyg om medfinansiering från de deltagande företagen bifogas.

HÖG 10 Ekonomisk redovisning (årlig)

Diarienummer	20100258
Projektnamn	COINS
Projekthuvudman	Mittuniversitetet
Adress	851 70 Sundsvall
Organisationsnummer	202100-4524
Stödbelopp	3 000 000 kr
Projekttid	2011-04-01–2014-03-31

Kostnader aktuellt år

Finansiering från KK-stiftelsen		
1.1 Lönekostnader, inkl. påslag		
Namn	Position	Bokförda kostnader
Tingting Zhang	professor/projektledare	435 740
Filip Barac	doktorand	172
Wei Shen	doktorand	282 040
Youzhi Xu	senior gästforskare	139 169
Total lönekostnad, exkl. lärosätesoverhead		857 122
Overhead	51,0%	
Total lönekostnad, inkl. lärosätesoverhead		1 294 254
Övriga kostnader		
1.2 Kostnad för utrustning		35 614
1.3 Materialkostnad		0
1.4 Resekostnader		-20 847
1.4 Lokalkostnader		15 905
1.6 Övrigt		817
Total övriga kostnad		31 489
Total kostnad inkl. lärosätesoverhead		1 325 743

Underskrift av redovisningsansvarig

Underskrift projektledare

Namnförtydligande

Namnförtydligande

HÖG 10 Ekonomisk redovisning (årlig)

Diarienummer	20120330
Projektnamn	Robust Wireless Communication
Projekthuvudman	Anders Söderholm
Adress	MIUN, 851 70 Sundsvall
Organisationsnummer	202100-4524
Stödbelopp	1 077 348 kr
Projekttid	2013-01-01–2014-12-31

Kostnader aktuellt år

Finansiering från KK-stiftelsen		
1.1 Lönekostnader, inkl. påslag		
Namn	Position	Bokförda kostnader
Mikael Gidlund	gästprofessor/projektleda	0
ABB har ännu inte utfört faktureringen av kostnader för		
Mikael Gidlund bland annat på grund av omorganisation		
inom företaget. Fakturering kommer att ske ske under		
april 2014 för hela projektperioden fram till dess.		
Total lönekostnad, exkl. lärosätesoverhead		0
Overhead	51,0%	
Total lönekostnad, inkl. lärosätesoverhead		0
Övriga kostnader		
1.2 Kostnad för utrustning		0
1.3 Materialkostnad		0
1.4 Resekostnader		0
1.4 Lokalkostnader		0
1.6 Övrigt		0
Total övriga kostnad		0
Total kostnad inkl. lärosätesoverhead		0

Underskrift av redovisningsansvarig

Underskrift projektledare

Namnförtydligande

Namnförtydligande

Ekonomisk redovisning (slutlig) - HÖG 10

Diarienummer	20120326
Projektnamn	Vätska-substrat växelverkan för tryckteknik: ett nanoperspektiv
Projektledare	Petru Niga, Jonas Örtegren
Lärosäte	Mittuniversitetet
Projekttid	2013-01-04 --- 2013-12-31

Bidrag KK-stiftelsen

	Bokförda intäkter
Bidrag från KK-stiftelsen	**780 000**

Bidrag Företag

SCA R & D Centre	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	306	800	121 600
Interna resurser: anv. av dyrbar utr.			29 383
Totalt bidrag			**150 983**

Stora Enso	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	70	800	56 000
Interna resurser: anv. av dyrbar utr.			35 000
Totalt bidrag			**91 000**

Metsä Board	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	100	800	80 000
Interna resurser: anv. av dyrbar utr.			60 000
Totalt bidrag			**140 000**

MoRe Research	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	128	800	102 400
Interna resurser: anv. av dyrbar utr.			47 000
Totalt bidrag			**149 400**

Sensient Imaging Technologies SA	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			0
Interna resurser: arbetstid	108	800	86 400
Interna resurser: anv. av dyrbar utr.			46 000
Totalt bidrag			**132 400**

OCE *	***Antal tim***	***kr/tim***	***Totalt kkr***
Kontanta medel som överförs till *högskolan*			
Interna resurser: arbetstid			*
Interna resurser: anv. av dyrbar utr.			*
Totalt bidrag			*

Kostnader Mittuniversitetet

Typ av kostnader		**Bokförda kostnader**
Lönekostnader (inkl. sociala avgifter per anställd)		
Jonas Örtegren		29 383
Petru Niga		386 933
Översättning		1 900
OH-pålägg	31,08%	
Total lönekostnad		548 216
Utrustning		10 303
Material		53 526
Resor		74 412
Lokaler		82 696
Övriga kostnader		10 847
Totalt kostnader i kkr		**780 000**

*** We will supplement with the information as soon as we receive it**

Observera: Till den ekonomiska rapporteringen ska intyg om medfinansiering från de deltagande företagen bifogas.

HÖG 10 Ekonomisk redovisning (årlig)

Diarienummer	20120328
Projektnamn	PlenoCap
Projekthuvudman	Mittuniversitetet
Adress	851 70 Sundsvall
Organisationsnummer	202100-4524
Stödbelopp	2 102 344 kr
Projekttid	2013-04-01--2015-03-31

Kostnader aktuellt år

Finansiering från KK-stiftelsen

1.1 Lönekostnader, inkl. påslag

Namn	Position	Bokförda kostnader
Roger Olsson	forskare/projektledare	473 793
Total lönekostnad, exkl. lärosätesoverhead		473 793
Overhead	51,0%	
Total lönekostnad, inkl. lärosätesoverhead		715 428

Övriga kostnader	
1.2 Kostnad för utrustning	62 457
1.3 Materialkostnad	3 330
1.4 Resekostnader	2 600
1.4 Lokalkostnader	22 165
1.6 Övrigt	12 362
Total övriga kostnad	**102 913**
Total kostnad inkl. lärosätesoverhead	**818 341**

Underskrift av redovisningsansvarig

Underskrift projektledare

Namnförtydligande

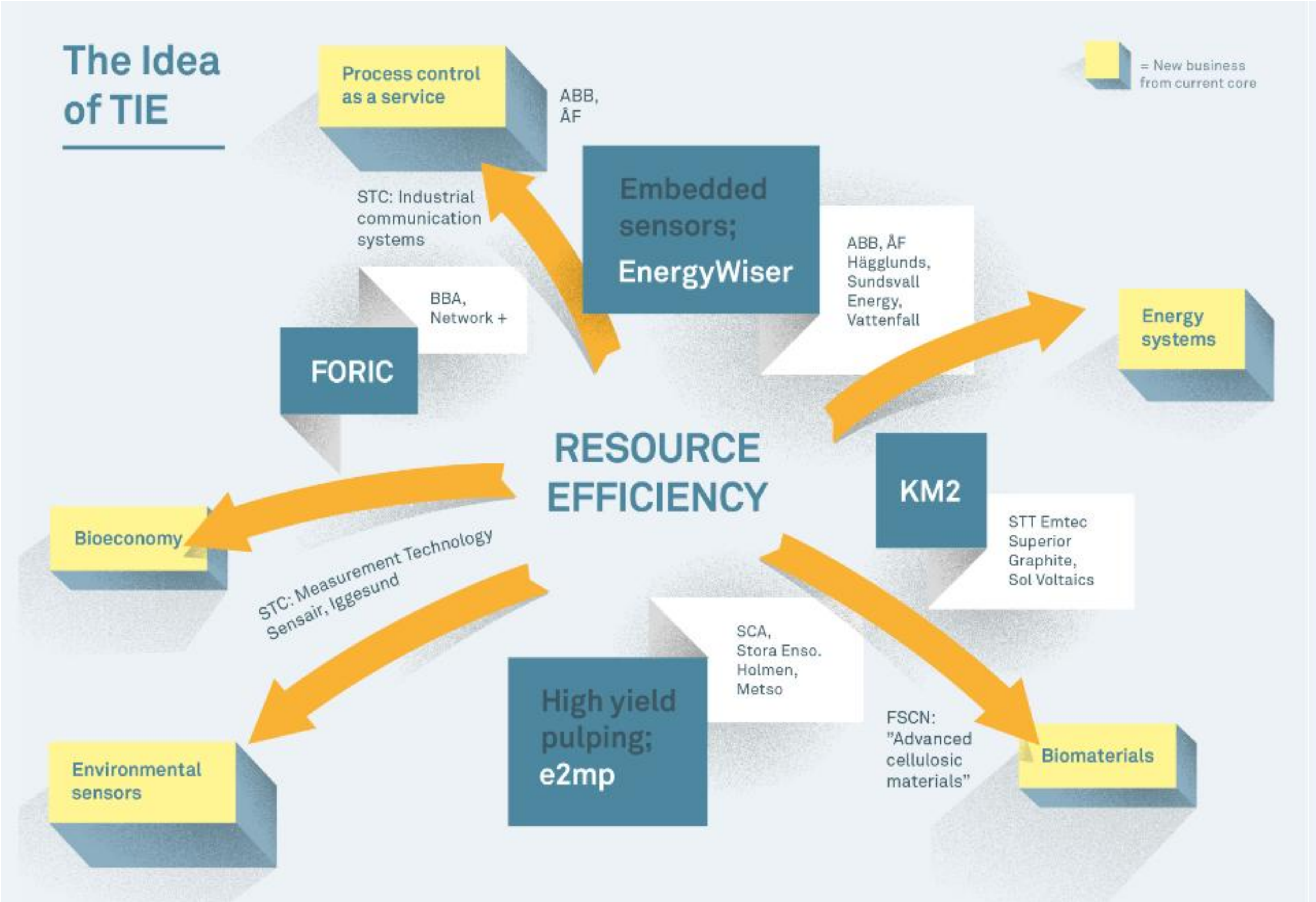
Namnförtydligande

Appendix F – Preliminary Portfolio of KK Research Actions 2015-2017

Portfolio of KK-foundation Research Actions

	2015	2016	2017
Current projects			
e2mp - rp	6 756 314	4 669 413	
FORIC	3 750 000	5 188 000	5 188 000
Flex	823 393		
Robust Wireless Communication	96 220		
Paper Solar Cells	1 673 548	1 828 064	470 804
Light-weight Structural Composites from Fibre-based Materials, Reliability-based Design	1 377 096	1 389 220	233 149
Characterization of wood disintegration processes	1 078 302	1 027 181	305 355
High Frequency Medium Power Isolated Converters	734 277	747 662	189 341
ID-POS - Large Areas for RFID Identification, Positioning and Interaction	995 719	1 016 110	217 804
PlenoCap - plenoptisk infångning och beräkningsbaserad fotografering	153 286		
	17 438 155	**15 865 650**	**6 604 453**

New Proposals			
EnergyWiser (under revision)	5 000 000	5 000 000	5 000 000
Next Generation Predictable and Reliable Wireless Industrial Communication Systems	1 350 000	1 350 000	1 300 000
M2M Communication in Smart Grids	1 350 000	1 350 000	1 300 000
Scalable Energy Harvesting and Storage Systems in Off-Grid Applications	1 000 000	1 000 000	
Surface characterization of industrial large area products	1 350 000	1 350 000	1 300 000
Synergy - KM2, Systems for Energy and IT	200 000	200 000	200 000
Electrical energy from thermal processes in the industry by thermo-electro generation	1 350 000	1 350 000	1 300 000
Surface engineering for functional materials	1 000 000	1 000 000	
Low-cost solution-processed metal films for flexible electronics	1 000 000	1 000 000	
Hardwood CTMP in paperboard products with high demands for printability	1 350 000	1 350 000	1 300 000
Guest professor: Biomaterial upgrading	300 000		
Data Analytics in Industrial Networks	1 350 000	1 350 000	1 300 000
Permanent Magnet DC Motor with On-Rotor-Drive System	1 000 000	1 000 000	1 000 000
X-ray microscopy of wood fibres using spectral methods	1 000 000	1 000 000	1 000 000
Optical Measurements for Geometry Characterization in Forestry	1 350 000	1 350 000	1 300 000
Fibre network as microfluidic system for healthcare and hygiene	1 333 333	1 333 333	1 333 333
	21 283 333	**20 983 333**	**17 633 333**
Total	**38 721 488**	**36 848 983**	**24 237 786**


The Idea
of TIE
Process control
as a service
ABB,
ÅF
STC: Industrial
communication
systems
Embedded
sensors;
EnergyWiser
ABB, ÅF
Hägglunds,
Sundsvall
Energy,
Vattenfall
= New business
from current core
Energy
systems
BBA,
Network +
FORIC
RESOURCE
EFFICIENCY
KM2
STT Emtec
Superior
Graphite,
Sol Voltaics
Bioeconomy
STC: Measurement Technology
Sensair, Iggesund
SCA,
Stora Enso.
Holmen,
Metso
High yield
pulping;
e2mp
FSCN:
"Advanced
cellulosic
materials"
Biomaterials
Environmental
sensors

Mittuniversitetet

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