ForestValue

NEWSLETTER #9

JUNE 2022

Picture by Gustav Gullstrand on Unsplash

CONTENT

GREETINGS FROM THE COORDINATOR

Dear ForestValue Friends,

a lot has happened since our previous newsletter in November 2021. Although different countries are still at different stages of the pandemic, in some ways, life is starting to return to a "new normal": people are slowly going back to the office and there are more and more traditional physical meetings. However, just when we started recovering from the shock of the COVID-19 pandemic, Russia attacked Ukraine and now we are facing this terrible war in Ukraine causing unmeasurable suffering to civilians, at the same time we are all unsure about what will happen next… This all makes global cooperation more important than ever, working together towards a better world. The ForestValue consortium is trying to do its tiny part in this, widening participation and supporting and strengthening the European Research Area.

Picture by Mika Kallio

In our November issue, I was telling you that the Strategic Working Group on Forests and Forestry Research and Innovation of the Standing Committee on Agricultural Research (SCAR FOREST) had been working to collect a fiche document describing a possible European Partnership on Forestry. This fact sheet was submitted to the European Commission in November and mid-February they received the first feedback on this from the EC services. It is still quite unofficial since any future candidate European Partnerships will be discussed as part of the preparation of the second Strategic Plan of Horizon Europe 2024-2027, in close collaboration with Member States, and this process has not yet been officially initiated. Anyways, we are carefully monitoring the developments and will make every effort to support the process.

However, there has been another important development to support the preparation of a possible European research and innovation partnership on forests. In our June 2021 issue, I wrote that the Horizon Europe Work Programme of 2021-22 of Cluster 6 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' includes a call topic titled 'Strengthening the European forest-based research and innovation ecosystem'. Now, one of the expected outcomes of this call is to support the preparation for a possible European research and innovation partnership on forests under the Horizon Europe Programme. In February 2022 our team of 16 partners from 10 countries distributed across Europe (composed of research organizations as well as of representatives of government, industry and societal groups) submitted a proposal under this call, the effort officially coordinated by the European Forest Institute (EFI). And on the 8th of June we now got the excellent news: our EUFORE proposal was selected for funding and we expect to get started in autumn 2022. This 48-month project will implement a valuable co-design process for forestry and the forest-based sector in a multi-actor approach, so everyone's input is valuable and needed. More information will follow soon, stay tuned!

The ForestValue consortium has also initiated another joint effort and a consortium of 14 owners and managers of national and regional RDI programmes in 12 countries submitted in April a CSA proposal (coordinated by MMM, FI) under the call HORIZON-WIDERA-2022-ERA-01: Support for policy makers - Programme level collaboration between national R&I programmes. If we would be successful with this, the consortium would start with a set of joint actions, aiming to implementation of a new joint call(s), resulting in the funding of transnational collaborative R&I projects in the area of forest-based bioeconomy. The proposal also includes a portfolio of actions that aim at building up R&I capacities especially in EU13, Ukraine and Republic of Moldova. Fingers crossed for this one.

Finally, I would like to remind you of our save-the-date announcement:

SAVE THE DATE: ForestValue Final Conference 28-29 September 2022 in Madrid. Come and join us in Madrid to learn from ForestValue research projects' results & success stories and inspiring keynotes, to network and share experiences, and to participate in side activities. Stay tuned!

Hope to meet you in person in Madrid in September and now, hope you will enjoy reading our newsletter!

Take care, all the best,

Mika

Check out the Conference website: https://forestvalue.org/final-conference/

FORESTVALUE POLICY BRIEF, BASED ON THE RESULTS OF FORESTVALUE PROJECTS:

INCREASING SUSTAINABILITY AND RESILIENCE OF EUROPEAN FORESTS AND RELATED VALUE CHAINS - CHALLENGES AND SOLUTIONS IN TIMES OF CLIMATE CHANGE

During spring 2022 ForestValue has produced a Policy Brief booklet with the support of Trust-IT Services, provider of the Horizon Results Booster, funded by the European Commission. The Policy Brief has been written by 12 ForestValue projects and project groups that took part in the Horizon Results Booster and it will soon be available in full on the ForestValue website.

In the policy brief, we draw from a set of insights and lessons learnt that are based on recent ForestValue projects around innovative sustainable management of multifunctional forests and innovative industrial production and processing technologies, products, concepts and services. The main solutions offered from the projects range from (among others) forest management and logistics solutions to wood construction material innovations and guidelines, and more. All this aims to contribute to ongoing challenges in Europe around maintaining and increasing sustainability and resilience of European forests and related value chains in times of climate change.

The contributors represent a multidisciplinary set of scholars, researchers and practitioners involved in either implementing forest-based solutions, researching forest policy and governance, or finding technological solutions to support the forestry and forest-based industries in remaining competitive and efficient providers of sustainable bio-products and services.

One of the main challenges identified in this policy brief is that of intensifying collaboration between different stakeholders at both EU and national level in order to achieve the ambitious goals of the Green Deal and decarbonize the European economy. Our policy brief addresses this issue, providing dedicated recommendations across multiple policy levels (regional funders to pan-EU regulations) that highlight the need for

- better understanding of the challenges that are facing forest owners and operators, particularly the marginalized or smaller owners, and provide insights on how they can be supported,
- understanding of the latest technologies, methodologies, processes that should be encouraged for implementation or viewed positively for funding, and
- understanding the actual impacts of climate change to European forests and how this affects the wood economy.

The policy brief is elaborated within the context of the Horizon Results Booster (www.horizonresultsbooster.eu/), funded under Horizon 2020, and the recommendations are based upon the results of the projects participating in the HRB services.

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

FIRENWOOD – Improved fire design of engineered wood systems in buildings

The aim of FIRENWOOD is to select an easy-to-use test method for adhesive classification for engineered wood exposed to fire. Lately, FIRENWOOD partners have worked intensively to finish the planned fire tests, including the model-scale and full-scale furnace tests with glulam beams, cross-laminated timber and assemblies with the I-joists, a compartment fire test, and glued-in rods tests. The furnace tests were carefully monitored with thermocouples embedded into the specimens. The mass loss and charring depth were also investigated. The compartment was made using representative engineered wood systems (wood I-joist walls and ceiling). Two Glulam beams were also placed at the corners. 24 EPAL-pallets were placed inside the compartment and ignited to create the fire load. Deeper analysis is ongoing, and the classification method for wood adhesives will be proposed for Eurocode 5. Concerning the glued-in rods tests, three different test series have been carried out so far. The first series of tests is based on EN 302-1 and includes tensile tests and warm creep tests under normal temperature as well as under temperature load. Test series 2 included fire tests without mechanical loading of the test specimens with glued-in rods. The results from test series 2 shall show the heat development within the test specimens, especially at the rod and the glue line under different configurations and enable an adaptation/verification of thermal characteristic values for numerical simulation models. Test series 3 consists of warm creep tests of test specimens with glued-in rods. These should help to determine the behaviour of the adhesive under practical construction conditions and temperature loads. The critical temperatures of the adhesive systems that lead to failure of the joint are to be determined. Simulation work has also been carried out using test series 3 as a basis. The preliminary simulation results show that rods with larger diameters require less coverage due to a cooling effect caused by the high heat capacity of the steel.

Figure 4: Glulam beams during lift-off from the furnace after heat exposure (Picture by FIRENWOOD).

Figure 4: Unexposed side of loaded CLT specimen before fire exposure in a full-scale furnace. Specimen dimensions were approx. 4500 mm × 2000 mm × 150 mm. The applied load was approx. 2 kPa (2 kN/m²) (Picture by FIRENWOOD).

Figure 4: Unexposed side of a wall made of I-joist stud after fire exposure and before removal from the furnace (Picture by FIRENWOOD).

Figure 4: Construction of the compartment (Picture by FIRENWOOD).

Figure 5: Cleaned test specimen of test series 2 (glued-in rods) after the fire test (Picture by FIRENWOOD).

Figure 6: Flames emerging out from the room opening during the compartment experiment (Picture by FIRENWOOD).

Link to project website: https://risefr.com/services/research-and-assessments/firenwood

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

InnoCrossLam - Innovative Solutions for Cross Laminated Timber Structures

InnoCrossLam aims to increase the competitiveness of cross-laminated timber (CLT) as a versatile engineered product, by increasing its predictability in demanding design situations not covered by the guidelines of today, or codes and standards foreseeable in the near future. Core activities are numerical modelling and experimental testing, in order to gain further understanding about mechanical behaviour of CLT elements and connections between elements at various loading conditions.

Recently, we have successfully completed several testing campaigns and continued intense work on modelling and development of design approaches. In this newsletter, we provide some insight to our research work on CLT at in-plane shear loading conditions.

CLT at in-plane shear loading

The composition of CLT, with orthogonally oriented layers of laminations, makes prediction of load-bearing capacity - a complex task for many loading situations. One example of this is the case of in-plane shear loading, as pure in-plane shear loading in a wall element or in-plane beam loading (Figure 1). Prediction of load-bearing capacity with respect to shear failure over the glued crossing areas between flatwise-bonded laminations is one of the major challenges and suggested design approaches found in the research literature and in contemporary design codes and handbooks differ in several aspects. Our work focuses on development of rational and reliable models for this loading case and failure mode.

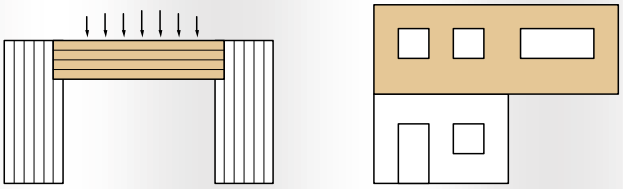
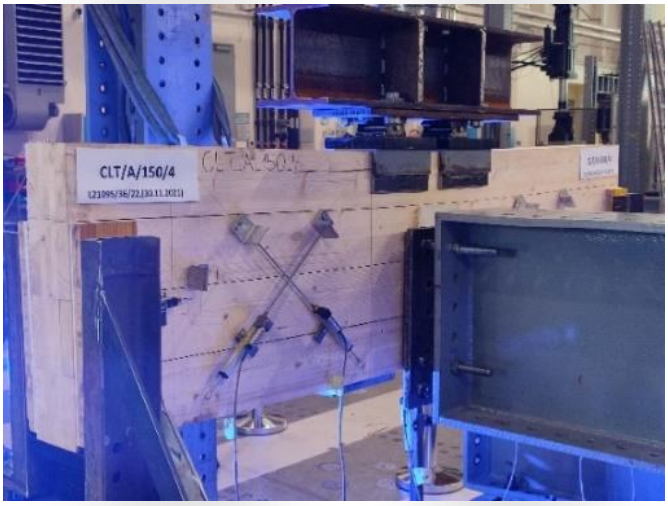


Figure 1: Examples of CLT at in-plane beam loading conditions

In order to gain understanding about the mechanical behaviour; numerical modelling and experimental testing of CLT beams at in-plane loading (Figure 2) have been performed.



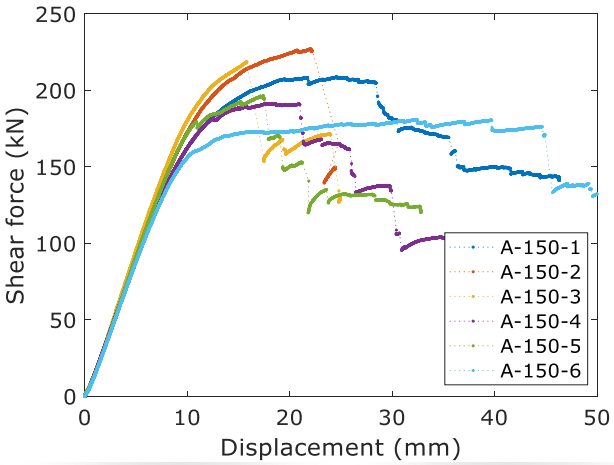


Figure 2: Testing of CLT at in-plane beam loading conditions. Test setup (above) and example of results in terms of sheer force vs. displacement (below). Picture by InnoCrossLam.

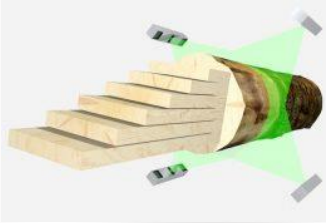
From these tests, a nonlinear behaviour of the global load vs displacement response was in general found. This may be explained by the local fracture behaviour at the crossing areas and giving a gradual decrease in stiffness before reaching the maximum load. This nonlinear behaviour and the potential for stress redistribution within a CLT element, composed of multiple layers and numerous individual crossing areas, hence should be considered in the further development work of design approaches for CLT at in-plane shear loading.

Other recent contributions within the project relate to:

- Development and implementation of material models for wood, including long-term effects related to time dependence and moisture content changes, and application to 3D simulations of CLT-based structures.
- Experimental testing and development of design approaches for CLT floors with openings.
- Experimental testing of high-capacity dowel-type connections for CLT-structures and investigations regarding brittle failure modes.
- Studies regarding numerical modelling of CLT-structures exposed to seismic actions based on linear and nonlinear modelling approaches.

Link to project website: http://innocrosslam.zag.si/

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES



READiStrength – Resource-Efficient And Data-driven integrated log and board Strength grading

Wood and wood products play an important role in Europe aiming at expanding the sustainable bio-based economy and successively reduce the dependence on fossil resources. The READiStrength project focuses on the production of wood material for the large area of construction timber products. In that area strength grading is a pre-requisite for sawn wood to be used for advanced construction and in engineered wood products, like glulam or cross-laminated timber. To make best use of Europe's wood resources in the future, the READiStrength project aims to improve current concepts of saw timber strength grading towards flexible and adaptive approaches prior to conversion at the raw material stage.

Objectives

- Develop round wood strength grading approaches for different specifications of construction timber or glulam, for contrasting industrial production systems of large high-end sawmills or smaller rural sawmills in European regions.
- Develop approaches for a continuous flow of wood quality information in the wood value chain for optimized strength grading.

Expected effects and results

- Combined knowledge in log X-ray and CT scanning, sawing optimisation, traceability and sawn timber strength grading to develop combined log and board strength grading concepts supported by newest technology.
- Application of novel concepts to important softwood species of European economic relevance & to regional, less used softwood species in the research design will enable a synchronous evolution of strength grading applicable for all softwood species;
- Grant new insights in the strengths and weaknesses of each species with respect to construction timber products.

Arrangement and implementation

- Novel strength grading scenarios for timber will be defined based on proven industrial standard and recent technology in round wood scanning. Interviews in the sawmill industry to depict the scanning technology and grading specifics and adapt new approaches for regional sawmill industry.
- 430 logs of softwoods from Sweden, Austria and Germany and their 1230 sawn boards are characterized and tested for strength. Information is collected according to a joint protocol for cross-referencing in data analysis and strength modelling.

Link to project website: www.ltu.se/research/subjects/Trateknik/Forskningsprojekt/READiStrength-1.189649?l=en

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

hardwood_joint - Innovative joints in hardwoods

After these hard two years for all of us with closed laboratories and no physical meetings and travels due to COVID-19, we are now approaching our final goals. All of us are working hard; transforming research results into publications, fortunately two abstracts have just been accepted for one of the most important conferences for timber engineers, the INTER 2022 in Germany. Also concerning recommendations for practical application, we are actually discussing our findings with our industry partners in order to produce a clear and understandable position paper. This paper is aimed at industrial development work, ie. to get our results into production, and also as a support to practitioners so that they can understand in a glimpse the most important issues when building with hardwoods.

Image 1: Oak joint with grooves in the shear plane (Picture by hardwood_joint)

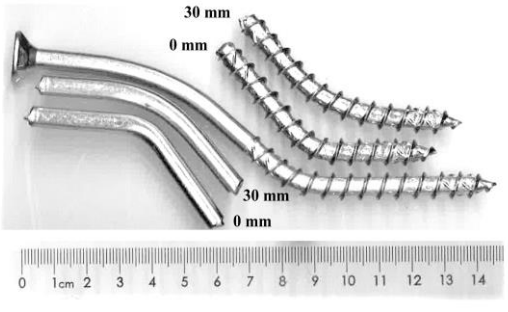


Image 2: Deformed screws taken from a birch joint after test (Picture by hardwood-joint)

Image 3: Oak specimen after a combined lateral and axial loading test with a screw (Picture by hardwood_joint)

StrongComposite – A novel material concept for high strength cellulose composites

The consortium of the ForestValue project "Strong Composite" had its final meeting on May 5th and May 6th 2022 in the NEST Building at Empa, Dübendorf, Switzerland. On the first day, the project members presented and discussed obtained results on the fabrication, functionalization, and property improvements of the cellulose materials and various resin binders, including a modular bio-based binder system, to implement high-performance cellulose composites. Stora Enso has upscaled the process to produce delignified wood veneers of a size of 1m2. After having achieved this demonstrator level, promising business cases are currently explored. Additionally, favourable sandwich structures consisting of partially delignified wood plus polymer in the middle layer, set by injection moulding were developed. The scalability of processes has been shown but needs to be developed further to be able to substitute less eco-friendly materials in various fields of application. This applies particularly to processes for highly sustainable cellulose composites impregnated with a novel bio-based binder from BASF, which can be scaled up for industrial use.

The second day was used for a stakeholder event to present interested companies a wide variety of demonstrators of the obtained cellulosic materials. More than 20 companies from various application fields registered and were informed of the research outcomes of the ERA-net ForestValue "Strong Composite" project in short presentations given by consortium members. In the following "hands-on" session, the participants could examine the various demonstrators, comprising densified and non-densified cellulose composites with various binder systems, laminates made of several stacked veneer layers or curved elements. The event was completed with a visit of different units in the Empa NEST building, including Vision Wood, and a lunch buffet facilitating further discussions.

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

MULTIFOREVER - Exploring the laboratory way to promote climate-adapted future forest trees – MULTIFOREVER demonstrates cost-effective, scalable plant production of somatic embryos with automation systems

Our forests are increasingly suffering from climate change, which affects reproduction, growth and the overall health of trees. The pressures from insects and pathogens are rising and drought is becoming an increasing problem. Breeding programs seek to address these problems by designing better-adapted trees. To capture the benefits from breeding programs in the most effective way, it is necessary to use clonal propagation techniques that allow for a shorter time period for a deployment of trees with improved characteristics, while combining it with a large-scale propagation of tree plants for reforestation.

For conifer trees, somatic embryogenesis (SE) has many advantages as a method for clonal propagation to obtain copies of a tree with desirable traits. With SE technology, valuable tree germplasm can be preserved for future forestry operations – offering possibilities to produce large numbers of improved plants in a cost-effective way.

SE plant propagation is a multi-step process where somatic embryos are initially produced from the seed embryo, then multiplied *in vitro* until enough embryos are obtained. Thereafter the somatic embryos are cultivated to mature and germinate into plantable seedlings. Every step of the process is labour intensive, requiring manual handling with forceps and this has until now prevented a breakthrough for SE plant production at a larger scale.

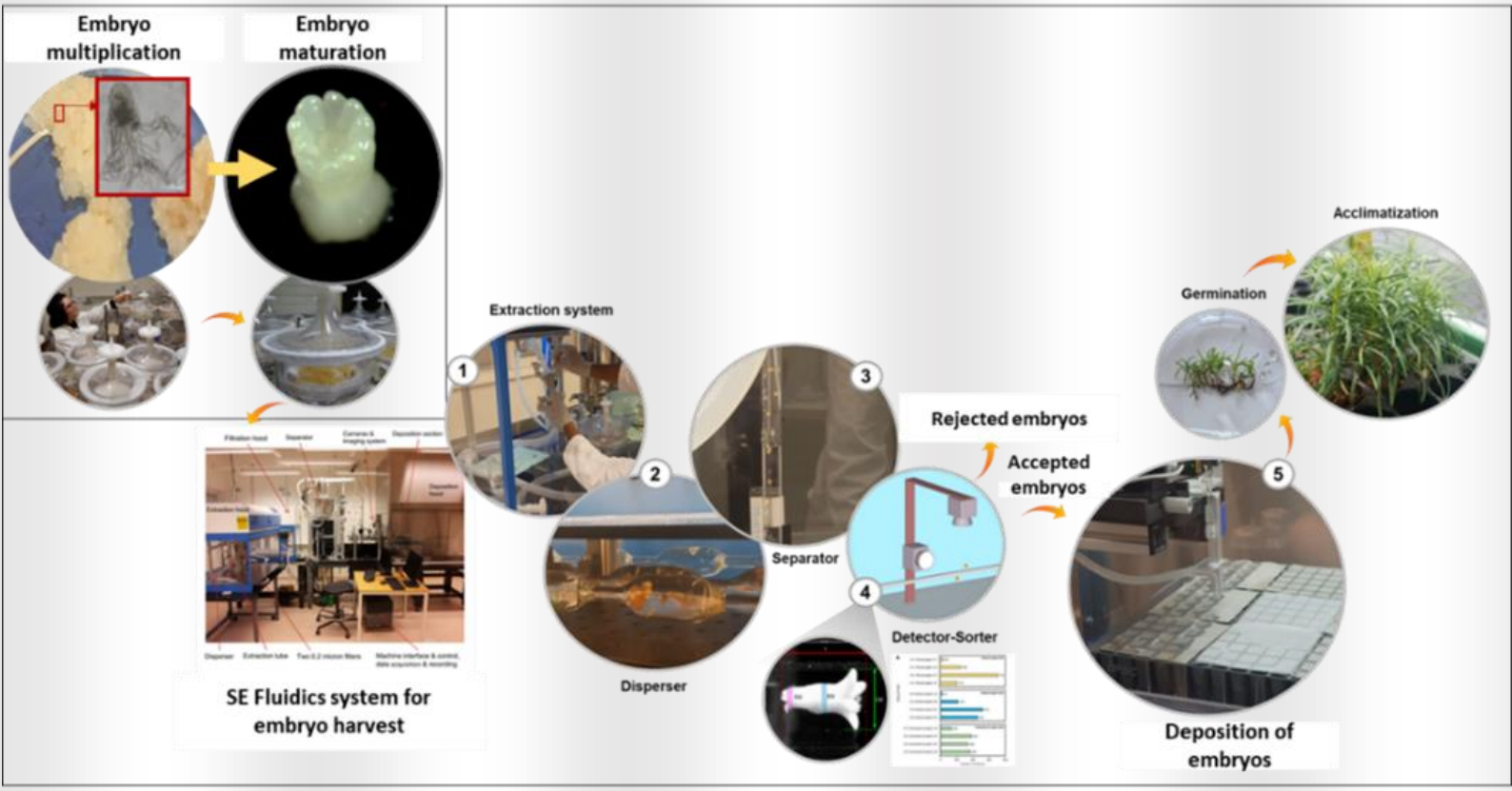


Figure 1: System for upscaling and sorting conifer somatic embryos. Somatic embryos are multiplied and developed into mature embryos in bioreactors (box top left). Mature embryos are morphologically characterized and harvested with the SE Fluidics system (process in pictures 1-5) at SLU, Sweden. Only somatic embryos of good quality are selected for germination (right). Illustration by Kim-Cuong Le, 2021.

The MULTIFOREVER project aims at investigating all aspects of applying SE technology on a larger scale to support Europe's forestry operations for future challenges. One part of the project is to explore how the SE plant production processes can be further optimized. For this purpose, we are running experiments with bioreactors and an automated harvesting system available in the SE lab facilities at the Umeå Plant Science Laboratory (UPSC), Swedish University of Agricultural Sciences (SLU) in Umeå, to test the efficiency of this technology across different commercially important conifer species. During the project, our bioreactors used for scaling up the SE plant production process have been tested with cultures from different conifer species (Nordmann fir, Hybrid larch, Douglas fir, Radiata pine, Maritime pine, Norway spruce) that were provided by the MULTIFOREVER project partners. The bioreactors can be used for multiplication, maturation and germination of somatic embryos and are part of the system that includes the so-called SE Fluidics system (Aidun and Egertsdotter 2018) for automated embryo characterisation (Video 1: phenotyping by multiple cameras) and harvest (Figure 1). We have tested this system with mature embryos from different conifer species and it works well across species provided the glass-tubes of the system is adjusted for the embryo dimensions as was recently demonstrated for Douglas fir during a partner-visit to UPSC (Video2: dispersion). Both, the bioreactors and the automated harvesting system technologies can greatly help facilitate the efficient scale up of selected, e.g. climate adapted, SE plants for plant production in forestry operations.

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

MultiForest – Management for multifunctionality in European forests in the era of bioeconomy

European forests face increased pressures for multiple forest ecosystem services demanded by society, while being also central for biodiversity conservation. MultiForest aims to improve the knowledge on how to strengthen forest multifunctionality and sustainability through addressing policy conflicts and through forest management.

What we have done:

New methodologies were developed to evaluate the (in)coherence between forest policies, both in terms of policy design and implementation. **First**, advanced policy analyses identify conflicts between the incoherent forest policy objectives and show policy areas that require further coordination and harmonisation. **Second**, translating policy objectives into long-term scenarios provides lessons on how to combine different forest management approaches to better avoid trade-offs between divergent policy objectives in the implementation.

What we have learned:

We have four main messages for the design of forest-related policies:

1) Policies should be more multifunctional by design, acknowledging the trade-offs between ecosystem services. For instance, we need to recognise the limits of using forest resources for climate change mitigation as those can conflict with biodiversity targets.
2) More diverse forest management alleviates the challenges related to trade-offs between forest ecosystem services and divergent societal demands.
3) Achieving the overall European policy targets depends on the distribution of efforts across member states and their successful national implementation
4) Before setting policy targets, one shall simultaneously keep in mind both the ecological boundaries and the resource needs.

Group picture 2 – Excursion to long-term forest research plots studied by TUM in the Bavarian Alps (Picture by MultiForest).

News:

How we can best disseminate these findings was one of the main discussion points at our final project meeting in Germany, organised by our partner from TUM. All partners very much enjoyed having the opportunity to meet physically in the beautiful Bavarian Alps. Our partner TUM reserved the Forest Station in Laubau for us, which has almost 100 years of history and is specialised in educating foresters about mountain forest management. How to manage the nearby mountain forests was shown to the project partners, along with two permanent research plots studied by TUM investigating continuous cover forestry approaches and their effects on the regeneration of the forest ecosystems. This was a "real" example of what we otherwise did study in our forest simulation task. In the local forest museum, we additionally learned about the history and challenges of forestry workers, and the importance of the forestry sector for the region – another "real life" example of the important economic ecosystem services we have studied in our research. A final half-day mountain hiking trip and an excursion to Berchtesgaden allowed us further to glimpse the beauty of the Bavarian mountain landscape – leaving us time to reflect on the project and look forward to the final steps.

Partners:

University of Jyväskylä (JYU), International Institute for Applied Systems Analysis (IIASA), Technical University of Munich (TUM), Swedish University of Agricultural Sciences (SLU), Finnish Environment Institute (SYKE), Norwegian Institute of Bioeconomy Research (NIBIO), FinnOpt Ltd.

For more information about the project visit:
www.jyu.fi/science/en/bioenv/research/natural-resources-and-environment/boreal-ecosystems-research-group/berg-projects-1/multiforest

View on the Berchtesgaden National Park (Picture by MultiForest).

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

NOBEL – Novel business models and mechanisms for the sustainable supply of and payment for forest ecosystem services

Europe's forests provide many different products and services, such as wood, hunting, and tourism, among many others. Yet, some services of great value to people are usually not traded on markets these include: carbon sequestration, water regulation, biodiversity conservation, and recreational experiences. With markets absent, private forest owners do not have sufficient incentive to enhance quality and quantity in supplying these services, a costly market failure.

Through a series of online meetings with policy makers and stakeholders in September and December 2021 as well as March 2022, the project team of NOBEL was able to work out policy recommendations for the implementation of payments for ecosystem services in the collaboration with the partners of the H2020 project SINCERE. The policy working papers suggests four pathways to secure better alignment between landowner incentives, stakeholder interests, and societal objectives towards Forest Ecosystem Services (FES) in Europe and identify key messages to European policymakers. Challenges and opportunities related to the supply of FES in Europe were identified (fig. left).

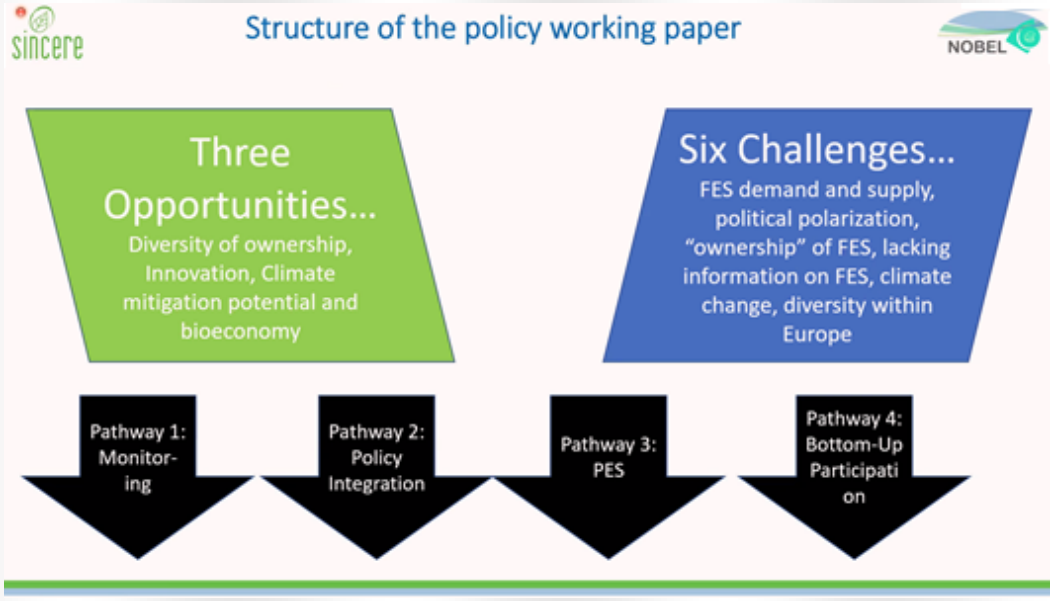


Figure 1: Structure of the policy working paper

Pathway 1 - Better information:

Improving the system for monitoring FES supply and demand is crucial, especially for regulating services (e.g. habitat provision and improvement of air quality) and cultural services (e.g. education and recreation). Agreeing on harmonized FES definitions, accompanied by standardized indicators, could greatly improve their monitoring on different spatial and temporal scales.

Pathway 2 - Policy integration:

An integrated forest policy framework is critical to ensure that various forest related policies at EU and member state level do not impede each other but work together in a manner that supports the management of Europe's forests for multiple FES. Increasing policy coordination and consistency in forest policy decision-making, in congruence with addressing trade-offs in implementation, implies: (a) aligning different forest-related policy instruments and ensuring that their objectives are backed-up by legal and financial means; (b) involving concerned societal groups and scientists systematically in goal formulation and implementation processes; and (c) monitoring policy implementation and adapting policies based on information.

Pathway 3 - Payments for Ecosystem Services:

An EU-wide PES system holds significant potential to advance the provision of such services in line with the novel EU forest policy framework. Guiding principles for establishing an EU-wide payment system for forest ecosystem services to incentivize their provision are: (a) pre-agreeing on systemic objectives and funding; (b) selecting cost-effective and flexible implementation mechanisms; (c) combining scientific knowledge with participatory co-design; (d) adopting long-term perspectives and commitments; and (e) identifying priority areas for different FES.

Pathway 4 - Bottom-up participation:

Innovations relating to multiple FES exist across Europe, but forest policy has been traditionally focusing on innovations for wood supply. There is a need to encourage and support innovation for the provision of multiple FES across Europe, through stakeholder engagement, and networking across sectors and policy levels. Participatory approaches in forest modelling and planning can reduce conflicts and secure societal acceptability of selected management alternatives. Based on experimentation with various policy instruments, coordination (or competition, where appropriate) between landowners could enhance the effectiveness of supplying multiple FES.

Find out much more in a commentary paper available here: https://doi.org/10.5281/zenodo.6393968

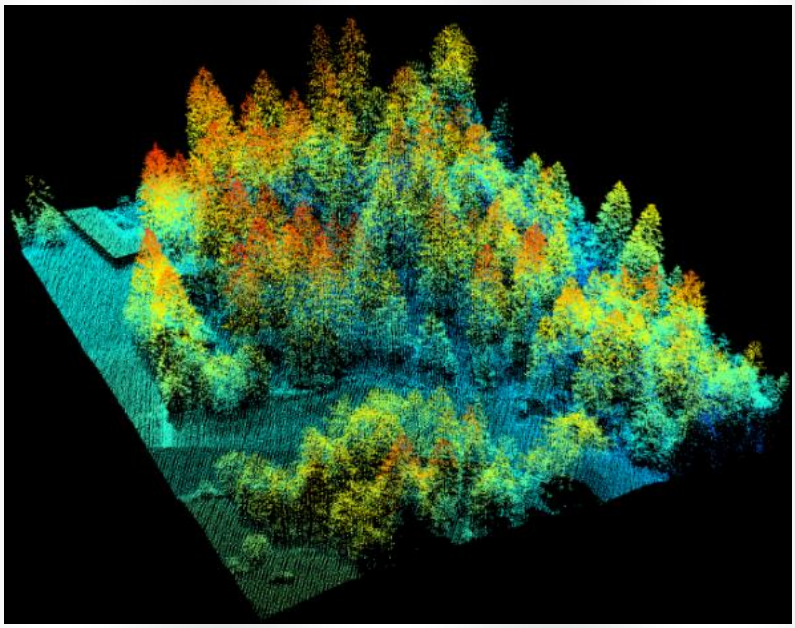
Further project activities on our homepage: https://nobel.boku.ac.at/

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

I-MAESTRO – Innovative forest MAnagEment STRategies for a resilient bioecOnomy under climate change and disturbances

If you want to investigate the influence of management on forest resilience after disturbances, you can of course put your walking shoes on and do field measurements. However, how can you evaluate forest areas of several hundreds of square kilometres? In forest science, we consider Airborne Laser Scanning (ALS) a strong solution for mapping forest characteristics – including its internal structure – at high resolution over wide areas. ALS is a remote sensing technology based on the emission of laser pulses. The laser light can penetrate the tree canopy and reflect on objects located inside the forest, or even by the ground. The Earth's surface is then modelled as point clouds in three dimensions with geometric information on the height of the vegetation, but also on its internal structure. In I-Maestro, we used ALS for two purposes: describing the forests to get an initial state for simulations, and analysing forest dynamics with repeated measurements.

We assess the influence of management on forest resilience after disturbances by using forest simulation on three case studies (Bauges in France, Sneznik in Slovenia, and Milicz in Poland). In the beginning, we used a combination of a sample of field plots and ALS data to create the initial map of forests for the simulations. We obtained a fairly realistic description of all trees in the landscape with ALS data using a two-step procedure. In the first step, models were calibrated to estimate stand level variables (basal area, mean diameter, and proportion of broadleaf trees) from the ALS point cloud geometry, using the field measurements. The maps for those stand level variables were then produced for all three case studies at 25 m resolution. In the second step, we generated tree level information on each of these 25 m resolution pixels using a downscaling algorithm we developed as part of our project.



Without any doubt: Technological developments and the increasing availability of remote sensing data including ALS data have brought new opportunities in the study of the dynamics of natural resources and the environment. In the research conducted in I-Maestro, we have shown that ALS data can be successfully applied to forest growth and mortality modelling. With high-resolution lidar data we can determine tree and stand attributes such as height, height increment and changes in tree density with increasing precision. This helps us to better understand forest ecosystem functioning and assess the provision of ecosystem services like wood production, biomass and carbon sequestration under climate change. The ability to use ALS to determine forest attributes over large areas has also been used by the project in predicting forest mortality risk. ALS data were key in explaining how stand attributes, site factors and site productivity influence susceptibility to tree mortality.

Link to project website: https://i-maestro.inrae.fr/

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

FunEnzFibres- From fundamentals to valorisation: Enzymatic oxidation of cellulosic fibres and underlying mechanism

The history of utilisation of cellulosic fibres in materials is long, and applications range is constantly diversifying due an urgent need to replace the fossil raw materials by renewable and biodegradable alternatives. Oxidation is one of the important methods in processing of cellulosic fibres in e.g. making medical or cosmetics ingredients, as well as papers, composites, textiles and cellulose derivatives. Cellulose oxidation can be carried out using chemical methods, such as ozonation, or treatment with nitroxyl radicals (TEMPO). Combination of fluorescent labelling technology and size exclusion chromatography, a method developed by Prof Antje Potthast's group at the University of Natural Resources and Life Sciences (BOKU) has proven to be a powerful tool in characterization of oxidized celluloses (1).

Microbial enzymes, which can be produced in large quantities industrially, are applied as green catalysts in processing of cellulosic fibres. For instance, researchers at VTT Technical research Centre of Finland have developed enzyme-aided technologies, utilizing cellulose hydrolysing enzymes, to convert cellulosic fibres into new type of high performance nanomaterial and sustainable regenerated textile fibres (2, 3). Cellulose-oxidizing enzymes were however not known until quite recently.

In 2010, Prof Vincent Eijsinks's research group at Norwegian University of Life Sciences (NMBU) published a remarkable discovery in the field of carbohydrate active enzymes: a protein, which was previously thought to be non-catalytic, was actually an enzyme with ability to catalyse oxidative degradation of crystalline chitin, an extremely recalcitrant biopolymer (4). Since then, variants of this enzymes type, lytic polysaccharide monooxygenases (LPMOs) capable of catalysing such reactions on va rious polysaccharides, including cellulose, have been discovered (5). Shortly after their discovery the LPMOs were also adopted by industry due to their ability to boost saccharification of cellulose in process for production of biofuels and chemicals.

During the past three years, the Forest Value project 'From fundamentals to valorisation: Enzymatic oxidation of cellulosic fibres and underlying mechanisms' (FunEnzFibres, 2019-2022) has explored the use of LPMOs in sustainable oxidative processing of cellulosic fibres. The project brought together expertise in LPMOs (NMBU), advanced cellulose analytics (BOKU) and enzymatic fibre processing and enzyme production (VTT) to generate fundamental knowledge on the LPMO catalysed reactions and to translate that into technology development. The project was supported by industrial advisory board covering pulp and paper manufactures (MetsäFibre, UPM-Kymmene Corporation), industrial enzyme producer (Novozymes) and tissues and textile-related industries (Essity GHC R&D Tissue, Acticell GmbH).

FunEnzFibres Team (Picture by FunEnzFibres

In the project, it was discovered that the LPMO variants exhibit remarkable difference in oxidation of different type of fibres and that the modular structure of the LPMOs can guide the outcome of the oxidation. The project generated a remarkable leap in analytics: while the LPMO catalysis has been earlier mostly studied by quantification of the soluble products, the methods adapted and developed in the project enabled quantification of the LPMO effects in the insoluble cellulose, revealing important information on mode of action of the different LPMO variants (6,7). Reaction efficiency, enabling lower enzyme loads and shorter retention times is important factor in the industrial catalysis. The project exploited newly discovered capability of LPMOs to utilize hydrogen peroxide for faster catalysis and high fibre consistency reactions (20 % dry matter) to boost the fibre modification. Industrially relevant microbial host, *Trichoderma reesei*, and synthetic biology-based protein expression system, were evaluated and exploited to acquire enzyme for scaled-up reactions (8, 9). The LPMO treatments affected technical properties of the fibres in enzyme-dependent manner, resulting in improved solubility in cellulose solvents and faster fibrillation, which is of importance in production e.g. regenerated textile fibres and nanocelluloses. The project results will be published in peer reviewed scientific articles.

For more information visit: www.nmbu.no/en/projects/node/38547

Research Gate page: www.researchgate.net/project/From-fundamentals-to-valorization-Enzymatic-oxidation-of-cellulosic-fibres-and-underlyig-mechanisms-FunEnzFibres

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10)

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

SMALLWOOD: Small diameter wood utilisation with innovative stand management for multifunctional forests and a growing sustainable bio-economy

The results from productivity studies in Sweden, Finland and Slovenia on an upgraded Bracke C16c accumulating felling head mounted on a Komatsu 901.4 harvester base machine are summarised in this article. Two work methods, boom corridor thinning and standard selective thinning were compared in dense small diameter stands regarding productivity of felling and bunching of whole trees and quality on the remaining stand.

Background

Tree biomass is an important resource in the transition from a fossil-based economy to a bioeconomy within the European Union (EU). In 2010, even-aged forests up to an age of 40 covered ~36 million ha across Europe, which shows an increased need for thinning work.

Selective thinning as in the left picture below (ST) is the most common thinning method used in Europe. With ST, usually subdominant, suppressed and low-quality trees with poor growth potential are removed (Fig. 1). In conventional pulpwood thinning only trees with a diameter at breast height above ~8–10 cm are removed. Smaller trees are regarded as un-merchantable. However, if whole (un-delimbed) small trees are harvested, biomass removal can be increased at least two-fold. This biomass can be used for bioenergy and/or bio-refining purposes.

Boom-corridor thinning (BCT) is a novel working method in which trees are cut with linear movements of the harvester's boom reach, along narrow (1–2 m wide) corridors, instead of cutting each tree selectively (Fig. 1). The aim was to study the effects of BCT and stand conditions on harvester productivity and thinning quality in dense small-diameter stands in comparison to ST.

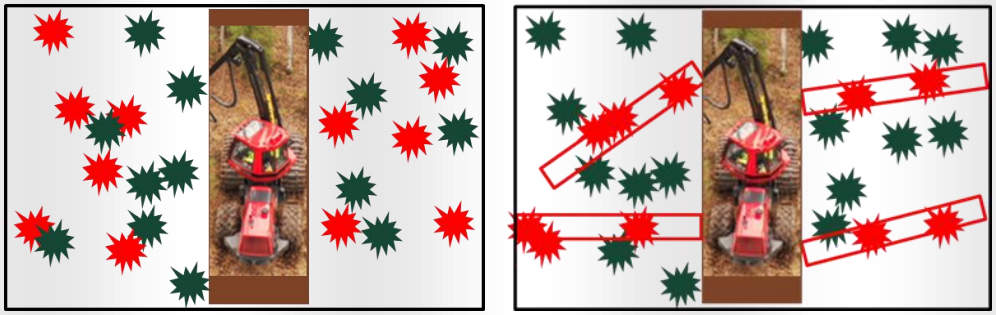


Figure 1. Selective thinning (left) and boom corridor thinning work methods (right).

Materials and methods

Field trials were carried out between autumn 2019 and spring 2020, in Sweden, Finland and Slovenia. The same harvester, Bracke C16c accumulating felling head and operator were used throughout trails. At each site:

- Dense, non-commercially thinned, small-diameter forest stands were selected, and time-study units were marked out and inventoried.
- Time-and-motion studies of the thinning harvester during ST and BCT were carried out.
- Cut biomass was either scaled or calculated using biomass functions.
- Remaining stand properties and thinning quality were inventoried.

Results

On average, no differences were found in quality on the remaining stands between BCT and ST. The thinning ratio i.e. the quota of diameter of the harvested and remaining trees averaged 0.7, while removal of the basal area averaged 56%. The strip-road width averaged 4.8 m and the share of strip-road area of the total harvested area averaged 24%

The total time consumption per tree was on average 28% less for BCT. The number of cut trees per crane cycle was on average 33% higher for BCT. The harvest productivity in BCT averaged 5.4 dry ton biomass per productive machine hour (about 11-m^3 solid biomass per hour) and yielded on average 16% higher productivity than ST. Thinning in small diameter dense stands results in rather large volumes. In most cases 30-60 dry tons of biomass per ha was harvested (about 60-120 m^3 solid biomass per ha)

Discussion and conclusions

Felling and bunching work with the Bracke C16 head in combination with BCT show great potential to make utilization of whole tree biomass from dense small diameter stands feasible. If BCT is applied with high selectivity, as in our trials, the remaining stand quality is high. With increase marked demand for woody biomass we can expect that BCT will become a common forest practice in EU in the near future.

References:

Bergström, D., Fernandez-Lacruz, R., Fuente, T., Höök, C., Krajnc, N., Malinen, J., Nuutinen, Y., Triplat, M. & Nordfjell, T. 2022. Effects of boom-corridor thinning on harvester productivity and residual stand structure, International Journal of Forest Engineering, DOI: 10.1080/14942119.2022.2058258

Link to project website: www.smallwood.eu/

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

CLICKdesign-Delivering fingertip knowledge to enable service life performance specification of wood

The work of the CLICKdesign consortium concludes. Through the difficulties of lockdown, we have successfully progressed resisting the temptation to muse how it may have been under 'normal' circumstances. We are proud of where we have reached including the proof-of-principle tool and new knowledge created that will help predict service life performance for wood in construction.

The CLICKdesign tool is public facing, easy and free to use. We have provided prototype functionality to predict service life of wood components based on exposure and use criteria and design and specification measures. The skill and endeavour of Lund University (Jonas Niklewski) has transitioned the tool in the last 3 months to a web-based solution. Originally constructed in Matlab our first industry feedback session highlighted challenges with accessibility. This significant achievement has opened the proof-of-concept for easy access.

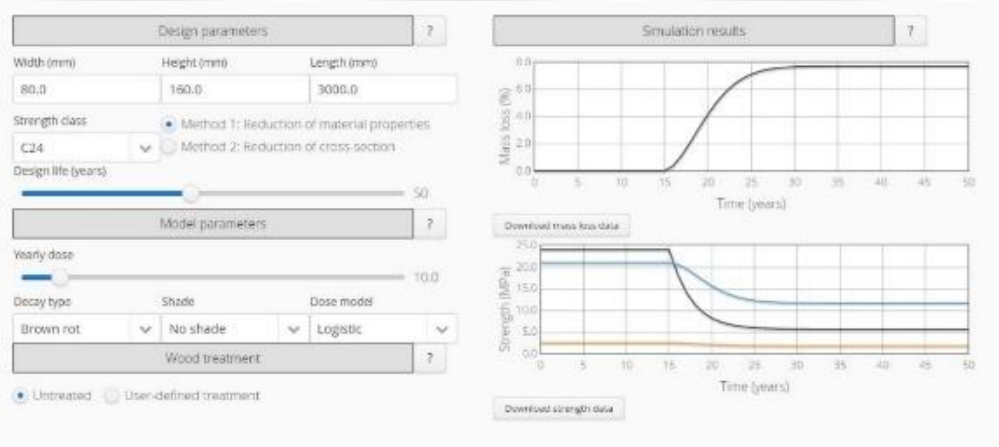
The CLICKdesign tool four modules:

1. **Decay:** Scientific evidence gathered by the University of Göttingen team and collaborators, especially NIBIO, deployed as new knowledge identified and filled gaps in relationships for the decay module. Aspects of microclimate, transformation to ground contact, vegetation and splashwater have advanced the decay module beyond state of the art.

2. **Aesthetics:** The change in appearance with service life - shown as a visualisation surface appearance change for exterior wood cladding as a panel or simple building. The industrious team at InnoRenew also progressed:
    - An original methodology for determination of the aesthetical limit state for identification of maintenance frequency.
    - A proof of principle tool "dynamic LCA" software tool for simulation of environmental impact of the building façade during the use phase considering maintenance activities.
    - A software solution for visualisation of aesthetical changes integrated with BIM.

3. **Termite & Insect:** FCBA, IRBI with input from University of Vigo have presented information for a termite and insect performance measure based on a probability of occurrence, materials insight and preventive measures. Significant new test data informing termite testing scenarios is influencing CEN standards now. This module is an interactive map of risk areas.

4. **Integrity:** A combination of exposure and beam cross section linked to experimental data for mass loss due to decay guide the integrity module developed by VTT. It provides an interactive tool highlighting the change in strength properties of timber.



We had our last face to face meeting at the end of May 2022. Fittingly, this was in Slovenia where we were heading in March 2020 until the pandemic happened. We wrapped up reporting including the educational package (EDUPAK) providing user support and guidance.

The relationships between exposure, material, and performance of wood products in part was achieved by an incredible 30 students furthering their academic careers in CLICKdesign with Masters and PhD studies. This legacy has also enabled the next generation research and development in ForestValue (2021) project WoodLCC. The prototype tool and public facing reports will help adoption by those interested in developing the tool into a formal customer facing software offer. *Thank you ForestValue and team CLICKdesign.*

For more information visit: https://bregroup.com/services/research/clickdesign/

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

AVATAR: Advanced Virtual Aptitude and Training Application in Real Time

German project partners verify findings about the effect of Operator Assistance Systems and host final field trials

In Germany, a pilot case study was conducted on the effects of the application of operator assistance systems (OAS) on time consumption of forwarder loading cycles. Duration of loading cycles is of relevance because the productivity of forwarders plays an important role in timber extraction, and about 50 % of the timber extraction work is consumed by the loading cycles of forwarders. Former studies already revealed the significant role of individual operator performances as a key factor for overall performance of mechanised systems. To help improve operator performance two major operator assisting systems have been developed and introduced by machine manufacturers over the last years.

One of these systems is called intelligent boom control (IBC) which means that machine operators no longer control every single joint and segment of the crane to reach for a certain object but rather have the computer calculate the most efficient interaction of the segments while the crane tip is steered by the operator towards an object. The other one is known under the label rotating cabin (RC) which is what it sounds like, a rotating cabin to have the operator always face directly in the direction of the crane tip. Both systems are meant to reduce mental strain during machine operations and raise working efficiency.

Three research questions were formulated for investigation:

1. ***How is time consumption of forwarder's loading cycles affected by applying IBC and rotating cabin?***
2. ***Do interactions or synergies result from the application of IBC and rotating cabin?***
3. ***What conditions with respect to loading distances and loading angles show most benefits of using these OAS?***

The test layout included 15 different loading positions in total in a typical working range for each setting. Three loading angles (55°, 90° and 125° azimuthal to the machine axis) were analysed. For each loading angle, five loading distances to the crane pillar were set up (4 m, 5.5 m, 7 m, 8.5 m, 10 m). Four variants were tested with either IBC or RC activated, both activated or both deactivated.

Results showed a clearly positive effect on operator performance by each of the assistance systems alone and a synergetic behaviour when both systems where used in combination. These results verified former findings made by the Department of Forest Work Science and Engineering.

The studies aimed at increasing forwarder efficiency as part of the harvester-forwarder dynamics in highly mechanised harvesting systems and to understand the contributing effect of operator assistance systems in order to develop a digital coach.

Final field trials of the Digital Coach, developed over the project period by all partners and as a major outcome of the project, will be conducted in the middle of June. For this reason, the project partners from Norway and Sweden come to the field test area near Arnsberg, Germany, and bring together the results of their work to demonstrate them altogether in a real-world case study.

Project Coordinator: Prof. Dr. Dirk Jaeger[1]

Author: Marius Kopetzky, M.Sc.[1]; Florian Hartsch, M.Sc.[1]

Link to project website: http://www.avatar.uni-goettingen.de/

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FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

GreenLane - Fast tracking value and resilience in industrial wood supply

The overall goal of the project was to develop virtual supply chain laboratory environments for testing alternative wood supply management practices under challenging climate scenarios. The focus was on implementing weather-driven models to ensure preserve log quality in the face of warmer weather and increasingly challenging seasonal trafficability.

Long lead times between harvesting and delivery lead to wood value losses resulting from fungi, insects or changing mechanical/chemical properties. To guarantee that harvested wood arrives at industry with the specified quality fulfilment, well-coordinated harvesting and transport management is important. The project focus during the final half-year has been on testing of alternative workshop approaches to ensuring delivery of fresh wood from forest to industry.

1. In the **sub-artic region** (Northern Sweden) seasonal accessibility is a primary driver for long lead-times. Weekly accessibility scenarios were developed, and a hybrid simulation/optimization approach was used to manage flows and track lead-times and log value loss. The wood flows in the simulation model were initiated by a monthly production plan optimized according to mill demand, weather and road (landing) accessibility. As production volumes accumulated at roadside, user-specified rules determined transport planning decisions. Stakeholder workshops were used for testing as well as discussion of the effects of weather and alternative transport decision rules on simulated lead times and value loss.

2. In the **continental-montane region** (Austria) windthrow and large-scale salvage operations, limited transport capacity is the primary driver for long lead times. A simulation model was created with a focus on contingency planning with multimodal (rail) solutions to reduce lead-times and log value loss. The *GreenLane IBM value-tracking model* was developed specifically for this region and was implemented for three climate zones (based on altitude). The wood flows in the simulation model started with pre-planned harvesting production to test the effects of user-specified alternatives for truck and rail transport capacity. The simulation model was designed such that it could be run independently by stakeholders. The workshops were designed to give the stakeholders the opportunity to experiment and experience the effect of their own decisions on lead-times and value loss.

3. In the **oceanic region** (Norway) seasonal accessibility is a primary driver for long lead-times. Weather-based accessibility scenarios were implemented in a simulated training environment for weekly coordination of purchase, production and transport between participants. Participants collaborate in selecting stands for purchase, allocating these to harvesting teams for production, before allocating flows to fulfil mill demand within the restrictions of truck capacity and lead-time limits. The *GreenLane RBC availability model* was developed specifically for this region and was implemented in the model to determine availability for harvesting and transport within three climate zones (based on distance from the coast). The training was run as a team competition for maximum net forest value, based on bonus points for high delivery fulfilment with penalties for value loss.

Workshop approaches

The respective approaches varied with respect to mathematical sophistication and workshop duration. Simulation approaches enabled rapid comparison of pre-selected decisions and system capacity alternatives within workshops of a few hours duration. The training environment approach required a minimum of one day of training, but allowed free experimentation with supply chain coordination routines. The training environment approach has now been further developed in a follow-up project as an on-line training tool (Virtual Wood Supply Arena) for forestry students. The first test was in March 2022 at Swedish University of Agricultural Sciences (SLU) in Sweden. Tests and development will continue at Norwegian University of Life Sciences (NMBU) in Norway and hopefully University Helsinki in Finland.

FORESTVALUE JOINT CALL 2017 – MAIN PROJECT OUTCOMES

DynaTTB-Dynamic Response of Tall Timber Buildings under Service Load

The DynaTTB project group could finally have an in-person project meeting again in December 2021, this time at University of Exeter in UK. During the meeting, a lot of interesting results from the full-scale measurements and FE-modelling of eight different tall timber buildings in Europe were presented. During the two days of discussions, a lot of common results where found that will be presented in the planned final Best Practice guide.

The planned title of the guide is: "Dynamic Properties of Multi-Storey Timber Structures for Wind-Induced Vibrations: Case Studies of Full-Scale Testing and Modelling".

The guide will include:

- Short guidelines
- State of the art
- Structural systems for Tall Timber Buildings
- Measurement of dynamic properties of Tall Timber Buildings
- Modelling of Tall Timber Buildings incl. details
- Wind-loads and acceleration calculations in SLS
- Description of each building – measurements and modelling

During the two days in Exeter, we also had to opportunity to test the newly installed VSimulator (https://vsimulators.co.uk/). In the simulator, we had the opportunity to be subjected to the same vibrations that was measured in one of the buildings as well as the maximum level of vibration allowed in the standards.

Image: Half the project group within the VSimulator at University of Exeter. Photo by Igor Gavic, InnoRenew.

Link to project website: https://www.dynattb.com/

UPCOMING EVENTS

20-22.06.2022

ForestValue Conference, Skellefteå, Sweden.

The hybrid conference is an initiative of the Swedish partners in the projects funded under the ForestValue Joint Call 2017 and will present the following seven projects in detail: CLICKdesign, DynaTTB, FIRENWOOD, hardwood_joint, InFutUReWood, InnoCrossLam and READiStrengt.

Monday, 20 June is dedicated to the projects' internal meetings. These project meetings will be held at the Skellefteå campus. The day will end with a presentation of the "Sara building" and a dinner at Sara. Tuesday 21 is a full conference day that ends with a conference dinner. Wednesday 22 June is a half-day conference, until noon. The conference ends with a "timber building safari" study tour in Skellefteå city after lunch.

Please note that if you intend to attend the conference in-person, you need to be prepared to show a valid COVID-19 Vaccination Certificate. To participate virtually, preregistration is required.

The agenda as available here. To register click here.

21.06.2022

MultiForest online webinar: From policies to management in Finnish forestry: Can we meet all needs?

Online webinar that aims to improve the knowledge on how to strengthen forest multifunctionality in policy making and management on 21 June 2022.

For more information visit: www.eventbrite.com/e/from-policies-to-management-in-finnish-forestry-can-we-meet-all-needs-tickets-319401046127

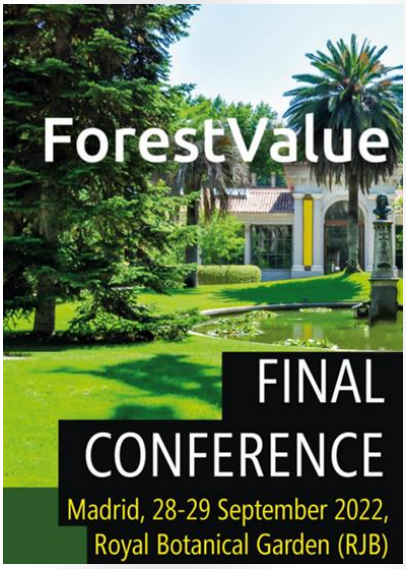
22-26.08.2022 (TBC)

MultiForest session at the ECCB conference "Forest Policies and their impacts on Biodiversity and Ecosystem Services in a changing world" in Prague.

For more information visit: www.eccb2022.eu/en/symposium-16

28.-29.09.2022

FORESTVALUE Final Conference, Madrid



We are pleased to invite you to the ForestValue Final Conference. After 5 years and 2 joint transnational calls and a long time without personal meetings we have a lot to present and discuss with our stakeholders from industry, academia, funding and policy-making organisations in the forest-based sector. Apart from selected keynotes, networking and other side-activities, the event will bring together JC2017 project coordinators to present their outcomes and results. We will also take advantage to kick-off and learn from the objectives and planned activities of the granted Projects in the JC2021 call.

We're looking forward to seeing you in Madrid!

Conference website: https://forestvalue.org/final-conference/

NB! The conference is limited to 100 participants. The first priority are ForestValue partners/projects and their stakeholders, the remaining seats will be allocated on a first-come-first-server basis. The conference will be live streamed.

MORE INFORMATION ON FORESTVALUE:

- https://forestvalue.org
- https://twitter.com/ForestValue2017
- www.linkedin.com/groups/12110816/

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