Collaborative shaping of Research Agendas in WoodWisdom-net

RESEARCH AREA 3 Sustainable, renewable raw material production

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Sub-area 3.1 Techniques for measurement and characterization of the properties of wood and fibres

3.1.1 STRUCTURE AND RHEOLOGY OF WOOD AND WOOD FIBERS

Positioning: Basic

Short Description: The properties of wood and wood fibers vary considerably between tree species and within any species (due to genotype, geographical location, age, growth rate etc.). For optimal allocation of wood into processes and products, and for developing new and improved processing techniques and products, more comprehensive knowledge on the structure and rheology of wood, wood fibers and wood fiber walls is needed. A more comprehensive knowledge can be gained only by developing more effective measurement and characterization methods for these different measurement scales, and by applying these systematically for a diversity of wood samples. Linking the structure of wood (density, knotwood, reaction wood, proportions of different cell types) on the rheology of wood (static and dynamic strength (compressive, shear, tensile) under varying conditions (moisture, temperature, time)) is of essential importance on wood products industry as well as on pulping of wood. The same applies on the structure and rheology of wood fibers (dimensions, strength) and of cellwalls (thickness and porosity of various wall layers, and their stress-strain behavior). Due to very different measurement scales, from nanometers to centimeters and up, a wide range of measurement methods have to be considered.

Justification: Improved understanding on the inherent properties of wood, as a raw material for wood products, pulp, paper and paperboard, promotes more efficient processing and use of it. More efficient use of wood enables increased production from the same amount of raw material, or reduces raw material demand for a specific product. More efficient processing enables reduced processing energy demand, perhaps simpler process-configurations, reduced water consumption and waste accumulation.

European relevance and collaboration: Europe has long and versatile history in wood related research. On the other hand, new measuring techniques are developed in increasing amounts also on other research areas. Implementing those methods into wood research will allow new insights on our widely used raw material. In addition to that, most of the wood to be utilized within European industry will originate from Europe also in the future. Thus, we need to explore the basic characteristics of European tree species. Potential collaboration partners are all the universities and research institutes dealing with wood material properties, + some biological, mechanical engineering, microscopy etc. research groups. The proposed research issue is to a large extent basic research, but it promotes industrial applications in a longer run.

3.1.2 Scanning

Positioning: Applied

Short Description: Develope methods and evices for internal scanning of wood, as means to test raw material and to apply the results by developing new tools to improve the processing of solid wood in the whole value chain. Support the development and adoption of IT concepts for the woodworking industry

Justification: The development and application of new scanning and IT tools for quality assurance of raw material will decrease the raw materila input, increase the raw material efficency, imporve the cost/performance ratio as well as will increase the supply chain added value

European relevance and collaboration: The topic concerns the entire European wood working industry. The challangeing targets should be solved in an integrated and transnational approach to obtain the highest output possible.

3.1.3 3D-Models of logs created with a photo modelling software

Positioning: Applied

Short Description: Aim of this research issue is to investigate the possibilities to record and archive log quality characteristics in sufficient accuracy based on digital images. For this purpose, a commercial 3D-Software (3D-Photomodeler) is used to create 3D-models of logs. First step is to test which requirements have to be achieved in order to develop the 3D-model. This includes several trials with a different number of photos from different positions and angles. The best combination will be used to create a model which is suitable for computer based measurements within the model. In a second step, the accuracy of virtual measuring in the model will be compared with real measuring performed on the log.

Justification: Research on logs and sawn timber implies that the logs have to be sawn into boards and is therefore destructive. Further measurements for verification or additional research aspects later on are therefore impossible. Precise 3D-models would allow to archive the logs or boards with their individual characteristics, so that further research or verification of former measurements would be possible at any time. This reduces research costs and makes it possible to use archived models for future investigations and different research approaches. It is also possible to exchange the 3D-models between research groups. In future, improved models could be used in an internet sales platform, so that customers interested in buying high quality logs could examine the timber via internet and decide whether it meets their demands or not.

European relevance and collaboration: Applied research in 3D-modelling is a complex issue. Best results will be achieved in an international team, in which different approaches are combined to create optimal solutions. This research could be implemented by research groups which work in the field of wood and timber quality. These are namely: INRA-ENGREF (France: Nancy/Champenoux); BRE - Building Research Establishment Ltd, Centre for Timber Technology and Construction (United Kingdom); Napier University, Centre for Timber Engineering (Scotland/Edingburgh); VTT Building and Transport (Finland); Chalmers University of Technology (Sweden).

3.1.4 Measuring the dimensional stability of sawn timber as a key to improved quality

Positioning: Applied

Short Description: Aim of this research is to investigate, which timber characteristics cause warp in timber for construction use. Warp has been measured until today with different measuring methods or devices of low accuracy. The results of these studies can not be compared as well when recurring the measurement several times using the same sample. By inventing and implementing a new measuring device (FRITS: Freiburg´s Improved Timber Scan) it is possible to scan the surface of the timber statements about the longitudinal changes of warp in different moisture conditions. Warp can be measured on the timber in e.g. wet and dry condition including highest position accuracy of the sample within two or more measurements. This accuracy permits to compare several measurements of different samples and will be used as a standard measuring device for warp in future research. It is possible to create 3D-Models of the timber in order to compare different types of warp.

Justification: Warp of sawn timber is one of the key quality problems, which faces the timber industry. Several grading rules include warp as an important grading criteria. To ensure the production of high quality wood products only timber should be used which is expected to show long-term dimensional stability. In order to improve timber quality, it is necessary to ascertain the causes for low dimensional stability especially warp. This includes measuring with best precision in order to match the standards of timber industry.

European relevance and collaboration: Standardised information about timber quality characteristics is important for the comparison of spruce timber from different stands and sites all over Europe. This research could be implemented by research groups which work in the field of wood and timber quality. These are namely: INRA-ENGREF (France: Nancy/Champenoux); BRE - Building Research Establishment Ltd, Centre for Timber Technology and Construction (United Kingdom); Napier University, Centre for Timber Engineering (Scotland/Edinburgh); VTT Building and Transport (Finland); Chalmers University of Technology (Sweden).

3.1.5 Impact of raw material quality on the properties of wood-based materials

Positioning: Applied

Short Description: For all industrial processes the variability of raw material quality is an important factor for the production of products with well-defined properties. In the wood-based panel industry, the raw material wood plays an important role in the quality of the finished products. Despite this, the measurement and analysis of the raw wood quality is only marginally considered especially in relation to the specific properties of the panels. Therefore, it would be desirable to find effective methods to analyse the wood quality and its impact on the quality of the properties of the wood-based materials. The main objective is to reduce production and raw material costs, to improve the properties of the panels and to maintain high quality standards.

Justification: The results can lead to better raw material efficiency in the wood-based panel industry. Especially by reducing the adhesive content, the emissions of the final products as well as the costs can be reduced.

European relevance and collaboration: As there are biological, chemical and physical impacts on the quality of wood which can have an effect on the properties of the panels, knowledge in different research areas is needed. Cooperation between experts in the field of wood biology, adhesive and process technology would be particularly conducive to fulfil the goals of the project.

3.1.6 Investigation of properties at the cell wall level

Positioning: Basic

Short Description: The cell wall level id the key scale to understand : - the elaboration of properties in trees, - possible way to change the fiber properties by industrial processes. The research would be devoted to elaborate a model able to predict fiber properties from its molecular organisation. Such a model, able to path from the discrete scale to the continuous scale would be fed and validate by several experimental investigation at this scale (micro-Xray beam, RMN, AFM, ESEM, Raman...)

Justification: Effect of global changes on the properties of wood elaborated in forests, Possibility of genetics improvement to control some of wodo properties Fiber modification (in surface or in volume) to elaborate new materials with specific properties

European relevance and collaboration: An European network could be rapidly implemented with the aid of some on-going COST actions

3.1.7 performance of biopolymer composite in fire

Positioning: Applied

Short Description: behaviour and classification of different type of biopolymers in fire by measuring heat rate release and smoke production with SBI test. comparison and selction of the most performant product. fire performance of these product after an ageing test-persistance of the performance.

Justification: promotion of use of biopolymer in accordance with the européan regulation for building construction. improvment of the fire behaviour of natural product. reduction of toxicity of smoke during a fire

European relevance and collaboration: the important developpment in Europe of new biopolymer composites and extension of use in building construction. technical centers and universities could work in this subject

3.1.8 Wood measurement by computer tomografic process.

Positioning: Applied

Short Description: Subject of the research program is a new method for log measurement under using a 3D measurement system. Hereby the timber logs are checked by using the computer tomografic process. Aim of this method is to analyse wood defects concerning the strength properties as compression strength, tensile strength and flexural behaviour. This process of testing the incoming logs is necessary, because the quality of standard saw products as two-edgded timber, girders, beams and coloums are usually assessed under this aspect. In the same way cracks, gnarls pitch problems and metal pieces in the logs can be analysed.

Justification: Improvement of the mechanical properties of wood- and timber products.

European relevance and collaboration: Strenghtening the sale of the sustainable material wood on the international markets

3.1.9 Characterization of the mechanical properties of wood at the cell-wall level

Positioning: Basic

Short Description: The mechanical properties of wood at the cell-wall level are insufficiently known. The difficulties are mainly due to the viscoelastic, heterogeneous and anisotropic character of the cell-wall layers. Improving measurements at this scale, like measuring the viscoelastic properties of the different cell-wall layers and constituents, may improve understanding of wood properties in relation with the orientation and the properties of the cellulose microfibrils, lignin and hemicelluloses. These properties could be linked with the macroscopic ones using multi-scale modelling. Measuring the elasto(plastic) properties of an homogeneous/isotropic material is now usually available at the microscopic scale by using nanoindentation and AFM techniques. Some studies show the possibility to measure elastic properties of anisotropic materials, like single crystal metal, some approaches try to determine the elastic properties of multi-layered isotropic material at the nano or micrometer scale and local measurements by nanoindentation on wood have already shown that mechanical properties of each cell wall layer can be estimated if these layers are sufficiently thick. The goal here is to extend these techniques to the case of any type of cell-wall layer using reverse identification of the mechanical properties. Furthermore these techniques are sensitive to residual stresses and can be exploited as well to evaluate, for example, growth stresses.

Justification: Developments in these techniques may allow one to measure mechanical properties heterogeneity in the cell wall layer together with a better understanding of the mechanical properties of wood macromolecules. Change in these properties and heterogeneity for different kind of wood (juvenile or reaction vs. normal wood) and for different kind of thermo-hygro-mechanical loadings (wood treatments) will be the second step of the development. All these progress at the micro-scale may allow a better understanding of wood properties in the tree (reaction or juvenile wood properties and formation, mechanical properties of fibres, improved control of wood structure...), transformation process and wood utilization (crack initiation and propagation due to growth stresses and wood properties at the micro-scale, cutting process, commercial use of reaction wood, paper and pulp industry...), heterogeneity and long-term reliability related problems (deformation during drying, sawing or in any utilization stages...).

European relevance and collaboration: This subject is already partly included in the scope of the COST Action E35 "Fracture mechanics and micromechanics of wood and wood composites with regard to wood machining". Similar or complementary techniques like nanoindentation and microtensile testing are used in different European countries (e.g., training course of E35 at the Max Planck Institute in Potsdam, 2004). This subject is mainly included in the scope of the starting COST Action E50 "Cell-wall macromolecules and reaction wood", trans-sectorial within FFP sector, which could provide the basis for a network of cooperation.

3.1.10 OPTIMISATION OF HEAT-TREATED WOOD QUALITY AND DURABILITY USING NON-DESTRUCTIVE EVALUATION DURING THE WHOLE LIFE-CYCLE OF WOOD

Positioning: Applied

Short Description: The research is based on the positive results of non-destructive evaluation of the heat-treated wood properties and the long term development work with non-destructive methods for wood. The non-destructive methods include, e.g. ultrasonics, acoustic emission, electrical impedance spectroscopy, microwaves, IR, NIR, X-rays, gamma rays, NMR, Raman, microCT and optical methods. The reference methods include e.g. mechanical testing, microscopic, physical and chemical analyses. The main aims: - Development of non-destructive evaluation techniques starting from living wood to optimise the classification process for heat-treatments and thus improving the quality and durability properties of heat-treated wood - Development of non-destructive evaluation methods for heat-treated wood quality classification Tasks: - Collecting wood materials for the project - Measurements including non-destructive methods during the whole life-cycle from living wood to decaying wood - Measurements before, during and after the heat-treatment process and in field tests - In field tests, wood materials from the same origin are compared including original wood, heat-treated wood and references. Decay, weather and pest resistance tests are used. - The non-destructive methods are used in parallel with the standard tests and new methods are developed for the analyses

Justification: The industrial production of heat-treated wood has begun, but the production volume is small compared to the potential of heat-treated wood. One of the most important factors affecting small production numbers is that the quality and durability properties of heat-treated wood and the factors affecting them are not comprehensively known. In this research project, the main aim is to produce novel solutions for the problem by comprehensive studies of heat-treated wood material during the whole life-cycle using non-destructive techniques. In the project, novel methods for fresh wood (living wood, sawn wood) are developed. The non-destructive evaluation of the material properties before heat-treatment enables classification based on the modification process and the end use. Thus wood material, which is most suitable for heat-treatment processes and includes low variations in quality, can be sorted in the wood material production chain. For example, high density, grain deviations, high extractive content and reaction wood may cause problems especially in heat-treatment. Also, the effect of natural durability of wood on the durability of heat-treated wood will be studied. The improvement of the biological durability of the heat-treated wood is highly important in many end use applications.

European relevance and collaboration: The research improves European knowledge to produce high quality and durable wood with increased economical value. The results of the project can be used to increase larger and efficient use of European wood, which has positive ecological impact in Europe. Univ. of Kuopio, Finland, Prof. Reijo Lappalainen, researcher Markku Tiitta: development of non-destructive methods, mechanical testing Metla, Finland, N.N: Finnish wood materials, field decay tests VTT, Finland, N.N: VOC-

analyses, field tests, decay analyses Technical University Munich, Prof. Wegener: Central European wood materials, extractives, decay tests BOKU Austria, Prof Alfred Teischinger: strength evaluation, moisture tests, microscopic analyses, SEM-analyses Luleå University of Technology, Wood material science, Ulla Westermark: Swedish wood materials, chemical analyses, NMR-analyses, strength tests Bundesforschungsanstalt für Forst- und Holzwirtschaft, Dr. Uwe Noldt: pest resistance tests, termite tests Stora-Enso, R & D Manager Jouko Silen and other industrial partners heat-treatment of wood materials, development of heat-treatment processes and quality demands from the industrial point of view

3.1.11 Indirect measuring of the decay resistance of timber and the prediction of service life

Positioning: Applied

Short Description: The naturally decay and mould resistant heartwood timber is again appreciated. This is partly due to the fact that the use of well-known preservatives has been forbidden before new, less harmful, preservatives or wood modification methods have been developed and properly tested. There are also people to whom the totally untreated timber is the preferred choice if such is available. As soon as the specific factors (extractives in the most cases) that provide the decay resistance for certain wood species have been revealed, the development of the method of indirect measuring can proceed. A non-destructive monitoring (ND) of the specific factors saves time and several shortcomings of decay tests in vitro or durability tests on field can be avoided. The most promising methods include IR-spectroscopy (in broad sense), electrical impedance, VOC-emissions, and color. I propose that the current Scots pine timber resources in North-Europe will be screened by an indirect chemical method, e.g. by Folin-Ciocalteu assay, in order to obtain estimates of the range and the distribution of decay resistance. A representative sample will be used to 1) verify is distribution with standardized durability tests (EN113, EN252, etc). and 2) to continue the development of ND-methods. At the same time 3) solutions for the prediction of real service life are explored.

Justification: Because of the wide durability variation within the heartwood timber the separation of sapwood and heartwood does not guarantee a uniform durability and hence does not help to fully exploit the supplies of naturally decay resistant timber. As soon as there are methods that are reliable enough and fast enough to screen timber in practical scale, the value of heartwood timber can be increased significantly. Furthermore, the better uniformity of the material makes it less difficult (but definitely not easy) to predict the actual service life of the wooden products in different kinds of service environment. The standardized service life predictions in the future are dreams of both suppliers and customers

European relevance and collaboration: There seems to be quite a lot of research activities going on in several institutes in several European countries concerning the fast indirect measuring of decay resistance of Scots pine and larch species. The joining of resources and the cooperation in the planning of further studies would certainly lead sooner to the technical breakthrough. In Finland the most active counterparts have recently been Metla, Kuopio University, Yti Research Centre and VTT.

3.1.12 Simultaneous Inline Measurement of Moisture Content and Density in Wood and Wood Products by Nuclear Magnetic Resonance

Positioning: Applied

Short Description: The aim of this project is the establishment of a novel method for the inline measurement of moisture content as well as density in wood and wood products using nuclear magnetic resonance (NMR). The precise estimation of moisture content is very important in many process steps in the wood industry. The moisture content can only be precisely determined if the local density is also known. Unlike other techniques, NMR can measure these quantities at the same time, giving more accurate and also more stable results. It will also be possible to obtain moisture and density profiles perpendicular to the surface, and to achieve a certain lateral resolution. In a first step the industry's demands on an inline system for measuring the moisture content will be identified. On the basis of these requirements, a prototype system will be set up and tested under laboratory conditions using various wood species and different kinds of panel products. The results obtained will be verified using established methods for determining the said quantities. The final step will be a long-term test under field conditions. The results will be compared to the performance of microwave systems and other existing inline techniques.

Justification: Quality control is a key issue for the enhanced use and for the sustainable and economic production of wood products. Among other quantities such as strength, stiffness, and dimensional accuracy, the moisture content is an extremely important property of logs, sawn timber, and wood based products. For optimum processing conditions in the paper industry, the moisture variation of logs should be as low as possible. Sorting the logs according to moisture content would be very helpful for a stable and economic production of paper products. The moisture content of sawn timber and wood based panels has to meet a certain target value in order to avoid problems with cracks, distortion, and decay. It also influences the measurement of other important properties including distortion. The lack of reliable, precise, and fast techniques for moisture determination often causes wood products to fall short of the customer's expectations. This can finally lead to a reduced use of wood. Finally, drying timber to the target moisture is very energy consuming. A better control of this process will diminish energy consumption. Consequently, the proposed research will improve the competitiveness of Europe's wood industry as well as the sustainable production of many consumer goods.

European relevance and collaboration: The wood-based sector is a very important part of the European industry, having a share of approximately 10 % in production value and also in employment. After a steady increase over the last ten years, the timber production in Europe is close to 100 million m3, representing a value of almost 25.000 million €. However, the wood industry is facing the same kind of challenges all over Europe: reducing production cost, increasing sustainability, and enhancing product quality. Thus, the development of novel techniques for quality control and process monitoring requires

the co-operation between leading European research institutes in member states such as Austria (Holzforschung Austria, Universities of Vienna and Graz), France (CTBA, University of Nantes), Germany (Fraunhofer WKI and IZfP, Universities of Hamburg, Munich, and Freiburg), United Kingdom (BioComposites Centre, TRADA), and the Nordic Countries (Riso National Laboratory) and also companies such as Grecon and Electronic Wood Systems (both Germany).

3.1.13 Fibre Quality in correlation with wood age and moisture content

Positioning: Applied

Short Description: Chemical (e.g. pH-value, acid capacity) and morphological research of wood (species, age) and fibre. Influence of process (refining, drying and pressing)on chemical bonding.

Justification: Influence of fibre quality and characteristics to the production of MDF. Prediction of product parameters, possibilities of production optimization e.g.; reduction of glue, hardener and urea application, reduction of reject production

European relevance and collaboration:

3.1.14 Non Destructive Testing coupled with predictive models for properties

Positioning: Applied

Short Description: The main objective is the prediction of technological properties according to the material structure. Observation tools have to be developed to describ the local structure (microscopy, x-ray tomography...). Finally, mathematical models have to be developed to predict the macroscopic properties of wood material. The most relevant parameters could be extracted from theses studies for an industrial application (cf next part)

Justification: The main application is a better optimization of the use of a variable ressource (optimization of process according to the actual local properties...). Local parameters are measured using CT-scanner (or other NDT techniques) and prediction is given by the predicting model before the transformation process.

European relevance and collaboration: Collaborations should be developed between Non Destructive specialists, wood properties modelling researchers and industrials.

3.1.15 Use of the Resistograph to estimate wood density in standing trees in Sitka spruce progeny tests

Positioning: Applied

Short Description: Assessment of wood density in standing trees by volumetric means is accurate but costly and time consuming. Indirect assessment using the Pilodyn is quick but unreliable at the individual trees level. A worthwhile alternative is the Resistograph which drills a 1.5mm wire through the tree with a fixed force. A graphic and digital read out is produced on a tree by tree basis. Analysis of wood density is possible at the individual tree level leading to estimation of breeding values and variance components. This could prove to be an important tool in the non-destructive estimation of wood density in young trees in progeny and clonal tests.

Justification: Use of such a machine would allow treesbreeders to more accuarately identify trees which are superior for wood density and understand their relationships with our qulaity and quantity traits. The trees already exist in existing tests. The results would be directly applicable in the choice of parents used in controlled crosses for deployment programmes.

European relevance and collaboration: Other orgainisations across Europe have used this machine or have contemplated it's use. The machine is very expensive (12k Euros) - and a few machines could perhaps be shared across Europe. Expertise on how to interpret the digital readout could also be shared across partners.

3.1.16 Chemical microscopy of wood and fibres

Positioning: Applied

Short Description: Chemical microscopy methods ideally combine the information about detailed chemical composition and localization at nanoscale of different components. The development of methods of chemical microscopy including spectrometric and imaging techniques is of great demand for advances and breakthroughs in investigation of wood and fibre materials. Different protocols for sample preparation and a multitude of techniques with diverse spatial resolution and chemical sensitivity need to be critically compared and further developped by selected experts in Europe.

Justification: The possible results include a deeper understand of wood and fibre materials at the nanoscale and a critical identification of artifacts that mislead conclusions and findings in many other research projects involving wood materials. Chemical microscopy methods can change radically the models and current knowldege of wood materials and the biosynthesis of wood components. Innovative functionalities of fibre materials can be also critically evaluated and further developped by the support of adequate chemical microscopy methods.

European relevance and collaboration: Chemical microscopy methods are commom advanced scientific tools for all the projects involved in this program. The ideal set-up for a project in this area would be the co-operation between excellent groups in the areas of imaging (ToF-SIMS, AFM, SEM, etc), spectroscopy (XPS, FTIR, XRD), labelling of functional groups, wood, fibre and cellulose chemistry. I would propose a colaboration between Åbo Akademi University (Prof. Fardim), BOKU in Austria (Prof. Paul Kosma), WURC in Sweden (Prof. Geoffrey Daniel), University of Muenster in Germany (Prof. Benninghoven) and other groups in France (CTP, CERMAV), Italy and Portugal (Aveiro). Additional collaboration with Japanese and Canadian groups could also be considered.

3.1.17 Property profiles for wood

Positioning: Applied

Short Description: Property profiles for wood (an anatomical structure in the tree and an engineering material in the industry).

Justification:

European relevance and collaboration: Groups in Sweden, Finland, Norway, France and Belgium.

3.1.18 IR spectroscopic and laser based wood and fibre characterisation

Positioning: Applied

Short Description: Chemical composition of wood and many properties wood like decay resistance and stiffness can be predicted with FTIR and NIR techniques. They could be also used as an online-method to sorrt timber or pulpwood for different processing and products. Laser light can be used to analyse wood structure with help of diffraction or fluorescence. applications can provide a fast method to characterise wood structure.

Justification: Fast and reliable measurement methods are needed in order to produce representative data of variation in wood structure and chemistry. It is of particular importance for modelling work. Also, fast measurement of material properties may optimise raw material utilisation for different end-products.

European relevance and collaboration: It is a multidisciplinary approach and experience in many fields is needed. Many european groups and laboratories work with these techniques.

3.1.19 New test methods for measure biological durability of modified wood

Positioning: Applied

Short Description: The present systems in codes and standards for testing and classification of durability of wooden products are insufficient in order to fulfil the needs of the producers, users and authorities. New technologies for modification and treatment of wood have been developed in many European countries. The target for many of these technologies is to improve the water resistance and durability against wood discolouring and destroying fungi. Any of these new technologies, however, is not based on biocide action of the active agent. Present standardised test methods, however, have been developed for wood treated with conventional biocides, like CCA . It is likely that the most important problems existing in the current test methods will automatically be addressed if they are extended to deal with new modified wood products to deliver data suitable for evaluating performance and service life. In the proposed research, different type of industrial or semi-industrial scale modified wood products (e.g. thermally modified, acetylated, furfurylated, DMDHEU modified, oil or wax modified or coated wood) will be used as a test material. Material will be tested using different laboratory and field test methods (e.g. outdoor weathering, UV-water sprinkling-frost cycles, modified EN 113, EN 152, mini block, double layer, multilayer tests). The condition of material will be analysed using different kinds of methods like change of colour, mass loss, modulus of elasticity, ultrasonic, electric impedance and IR spectra.

Justification: The central questions in focus will be "What new test methods and improvements to existing methods will be necessary in order to deliver a performance-based classification of modified wood products and how to measure the biological durability and performance of different wooden products". The study will result in relevant and simply testing methods for measuring the biological durability and performance of wood treated with non-biocidal methods. The durability of modified wood products in different applications can be predicted by means of these new test methods. Using mathematical models the data can be used for evaluation the service life of modified wood products. This can give new opportunities for wood industry to select, evaluate and develop new modified wood products, which have a low environmental impact, in different applications. The project will also give ideas for standardisation of new test methods in CEN.

European relevance and collaboration: The topic on improvement of existing biological test methods for modified wood products has raised interest throughout Europe. In European and Nordic research institutes, some work on developing new testing methods for non-biocidal treated wood have been carried out, but not very comprehensive work to widely compare new methods with existing standard methods have not executed. Exploiting the expertise of different European research groups leads a higher level confidence and acceptance of the development work concerning new test methods and their standardisation. The potential research groups implementing the

research would be the following: VTT, University of Kuopio, SP Swedish Testing and Research Institute, CTBA, Ghent University, Georg-August University, BFH Hamburg

3.1.20 Measurement of tree and wood quality based on images

Positioning: Applied

Short Description: This research would develop characterization measurements of wood quality based on images of growing trees, freshly cut trees (measuremetn in harvesters), at saw mills, and at pulp and paper mills. The characterization would address the use of trees and would both in wood products and as fibers.

Justification: The measurements are made to support optimization of wood logistics: the piece of wood is used where its properties provide the highest added value. Of particuar importance are measurement that allow separating low-volume high-added-value streams from high-volume streams.

European relevance and collaboration: Forestry and wood logistics are carried out Europe wide. Therefore measurements that support these activities must be adaptable to circumstances throughout Europe. Further,more, bringin together the research groups currently active in this area woudld strongly increase the impact both in short term improving of the loistics and in particular in developing new, added-value based lgoistics.

3.1.21 Project Leader looking into wood properties of Picea Sitchensis

Positioning: Applied

Short Description: Density and microfibril angle relationships within Sitka spruce. Accumulated sampling with assistance from (STFI) Sweden, using SilviScan. The aim would be to develope models/tools to understand the quality of standing timber for end product markets to enable sorting of logs before the sawmill. Fit for purpose.

Justification: The results would benifit both timber growers and sawmillers to maximise the use of the growing stock by selecting quality timber for the market place at the correct time. Reduce clear cutting and improve overall forest cover by secection process. The use of SiviScan would mean less destructive testing by taking cores form trees and examining the properties.

European relevance and collaboration: The results can benefit many industries, paper, sawmilling etc. Collaboration would be with STFI, Stockholm who are the only Northern hemisphere country to have such a machine that can measure an array of timber properties. Other research groups would be Centre for Timber Engineering, Edinburgh.

3.1.22 Advanced spectroscopy for the characterization of cellulosic fibres

Positioning: Basic

Short Description: The introduction of new advanced spectroscopy methods in cellulose research has given new more detailed information regarding cellulose and cellulose fibre structure. The molecular information from each method is very valuable. However, a combination of different spectroscopic methods will give an enhanced information and a better understanding of structural and materials properties in the cellulose fibre and how these depend upon structural elements and changes in the fibre wall.

Justification: Structural information such as e.g. crystal structure, hydrogen bonding and orientation of biopolymers are possible to obtain by spectroscopic methods and is very relevant to mechanical and physical properties of the products built up of them. The possibility to obtain information about stress transfer in the cellulose fibres gives additional important information for the use of cellulose fibers in renewable materials. Hygromechanical properties like dimensional stability will also find their roots in this extremely interesting field.

European relevance and collaboration: This project will lead to new tools and possibilities to develop improved products for the European forest industry. It is suitable for european collaboration because different groups are specialised in different spectroscopic methods and the advantage of correlating different advanced methods will only be achieved in this sort of collaboration. Possible research partners: KCL, HUT, BOKU, Max-Planck in Potsdam, STFI-Packforsk, KTH

3.1.23 Assessment of industrially important traits in young genetically modified plants

Positioning: Applied

Short Description: Increased understanding of how plants build up biomass and control growth in combination with new knowledge about the genetic regulation of key biosynthetic pathways has created a need for new methods to determine and follow industrially important traits. Examples can be control of lignin structure and quantity in wood, amount of hemicelluloses, fiber size and improved pest resistance. Methods that enable the measurement of industrially important properties of small sample sizes, i.e. green house grown material are therefore needed. In order to create methods for rapid screening methods such principal component analysis (PCA) can be used to correlate easily determined information with properties such as chemical composition, bleachability and perhaps even mechanical properties. Several suitable techniques are available that can be adopted for the screening of large sample series, e.g. ft-IR and py-GC-MS.

Justification: If early identification of important traits becomes possible the development of new transgenic plants will be greatly accelerated. Recently methods for the controlled flowering of plants also enable shorter times between generations. In combination with modern silviculture techniques this will enable the development of plants producing fibers with improved properties, trees that are easier to process and even production of speciality chemicals.

European relevance and collaboration: Although Sweden is a leading participant in the study of plant proteomics and plant genetics many groups in Europe are also very active in these fields and would be important collaborators in the described project. The development of new plants having attractive traits will ensure the continued development of European forestry related industries and help ensure a high competitiveness on a global market.

3.1.24 Land use of forest-products in the context of sustainable development

Positioning: Applied

Short Description: Considering the impact of land use within the life cycles is in its infancy. With respect to bio-energy and renewable resources, an account of the eminent importance of land use must be secured to enable the comparison of alternatives on an objective basis. The likelihood of a trade-off between bio energy in terms of decreasing greenhouse gas/emissions with increasing land use requirement must be reckoned with, to be able to identify and quantify most promising pathways towards sustainable wood products. Sustainable decisions can only be reached if land use and emissions reduction are interpreted collectively within the same method. Therefore the development of an evaluation and information tool for assessing both quantity of used land and the intensity of this usage (towards sustainable land use) has to be performed. The new method needs to be applied to existing systems that already contain environmental data and can thus be interpreted together with existing knowledge. Therefore it is necessary to differentiate between the assessment of land area, of land use intensity and of the type of land used. Therefore, an environmental indicator system of the land must be developed, which can be integrated into scheme of the standard Life Cycle Assessment evaluation.

Justification: Up to now it wasn't possible to evaluate land utilisation. Integration of data and knowledge into the everyday practice of analysing land intensive processes (similar to the integration of greenhouse gas emissions in the analysis of CO2 intensive processes) is necessary. The integration of land utilisation information into existing methods that have been approved and applied in practice (such as the standard LCA procedure) will be a step to solve this problem. Land surfaces can carry out a variety of functions. Special forest systems have alternative functions. The impacts of land utilisation should be credited with great significance in comparison to industrial product or process options. From a social standpoint, a reduction in land consumption has been a goal for a long time. However suitable methods and tools with which to effectively achieve this social consensus in the context of a complex, sustainable industrial/economic development were unfortunately still missing. Now that an evaluation technique is foreseeable, it is important that it is implemented into the decision support system (planning reliability, resource availability, sustainability). Accepted LCA methods (ISO) are available. A prerequisite to achive this research goal is to use already existing networks of experts (Cost actions, company networks).

European relevance and collaboration: Europe is very densely populated, which makes land often rarely available. Loss of natural territory became an increasing point of public discussion during the last years. A tool to evaluate land use within life cycle approaches throughout Europe is meanwhile more than necessary to enable reliable decision support. To develop this kind of method, the involvement of LCA groups, geo-ecologists, forest and agricultural scientists is necessary. A key goal is to integrate the method into every-day decision processes.

3.1.25 Harvester Mounted Systems for Resource Assessment

Positioning: Applied

Short Description: Measurement of stem and wood properties on the harvester head in order to optimise the cross-cutting of the timber and allocating it to the optimal end use. This will require developments in technology such as laser scanning and acoustic tools together with predictive models.

Justification: The optimal use of Europe's forest resource is crucial to remaining competitive in a global market. Ensuring the correct allocation of this resource at the earliest possible stage in the woodchain will avoid losses and reduce costs whilst avoiding unnecessary transport of material. This will all help to ensure the sustainability of the European wood industry.

European relevance and collaboration: The forest industry needs to be treated at a European level to ensure that it has a critical size to maintain competiveness. The skills to tackle these issues occur across Europe in a range of universities, research institutes and industrial bodies.

3.1.26 Tree Level Characterisation of Wood Properties

Positioning: Applied

Short Description: I believe we need to be able to quantify wood characteristics more successfully than is presently possible on a tree level. I believe it would be beneficial to be able to detect compression wood in trees before harvest. I also believe it essential to be able to measure timber characteristics accurately on a standing tree. I am interested in automatic shape recognition of compression wood cells, colorimetric determination of compression wood and chemical signals/triggers of compression wood in stems. I also propose that more work should be done with the assessment of timber quality on standing trees using methods such as combined ultrasonic and density measurements.

Justification: This research would benefit the wood processing industry. If it were possible to accurately determine the quality of each tree then it could be sent to a fit for purpose destination cutting both environmental and economic cost. It would also benefit the scientific community by providing rapid, non-destructive assessments of their predictions about cause and effects.

European relevance and collaboration: This issue requires sharing of ideas, technologies and experience not common to one organisation alone. Potential partners: CTE Lulea University of Technology Glasgow University Forest Research INRA VTT Forest Research Institute - Baden Wurrtemburg

3.1.27 Local variation in water-binding capacity of wood

Positioning: Basic

Short Description: Wood cell walls increase in volume when they absorb moisture. Distortion on drying is due principally to local differences in the distribution of volume expansion between longitudinal and transverse directions, a function of MFA. Little is known about local differences in moisture absorption at fixed relative humidity, but they certainly occur and will also influence distortion. Moisture can be measured with micrometer resolution by FTIR and comparative densitometry, and water forms can be distinguished by NMR

Justification: Better understanding of distortion in presence of reaction and juvenile wood

European relevance and collaboration: A number of parallel approaches are needed: results are relevant to a number of species. Glasgow; INRA; Helsinki; possibly other labs doing densitometry.

3.1.28 Measuring, characterizing and bucking wood with logging machines

Positioning: Applied

Short Description: Utilization of new sensor technology, models for predicting stem, wood and fibre properties, and new bucking algorithms based on this information, provide the fundamental basis for full integration of forest operations into different industrial processes. In a cut-to-length system different physical production processes start with the selection, felling and bucking procedures at harvesting in the forest. This requires development of: • Methods to measure key properties like breast height diameter and age of trees, shape of stems, spiral grain and stem scars at harvesting. • Models for predicting the impact of sawlog properties on solid wood products (Strength, shape stability, durability). • Models for predicting the impact of pulpwood properties and sawmill chips on paper properties (Surface and strength properties). • Models for predicting green density of logs. Freshness criteria and improved planning of haulage, kiln drying, and energy utilization. • Bucking systems maximizing the net-value of the sum of all the industrial value chains they concurrently serves. • Information systems including marking (ID) and positioning of logs and piles • Operational monitoring for declaration of environmental load, economic parameters etc. Development of models could be based on existing databases and field studies, measurement, bucking, information, marking and monitoring systems for logging machines could be developed through system analyses, simulated design and laboratory experiments.

Justification: There are large economic and environmental potentials in a consistent, reliable, well defined and cost-effective selection and supply of wood adapted to different products and processes. Wood supplies integrated into different products have the potential to improve production efficiency and to increase essential quality properties of final products. Development of measurement systems and models predicting stem wood and fibre properties of industrial relevance are most important issues to achieve real improvements in the forestry-wood chain. For example, the numbers of approved units of a product per m^3 of wood raw material could be raised and/or higher product quality and sharpened standards for structural timber, paper products etc… Lower costs and higher revenues and less emissions, at the same time meeting customers demands will considerably increase competitiveness of wood and fibre based products. This will increase the use of environmentally sound wood and fibre based products of gain for the whole society. Preconditions: Use of existing knowledge, adaptation of measurement systems and models to prevailing conditions in tree harvesters. Use of standards for information and communication.

European relevance and collaboration: The markets for forest products and timber are international. Manufactures of forest machines are international. Large markets, common requirements and supply of high quality supportive research will improve the possibilities to get affordable technical breakthroughs. Possible partners Skogforsk, SP Trätek/LTU, STFI, SLU, Sweden, Metla, VTT, University of Joensuu, Helsinki, Tampere, Metsäteho, Finland, Skogforsk NO, NTI, Norway, AFOCEL and INRA, France, Forestry

Commission, UK, KVL Denmark, Institut für Bodenkultur Austria, FOBAWI Germany.
Forest machine and information systems manufacturers.

3.1.29 Identification of compression wood in battens

Positioning: Applied

Short Description: The presence of compression wood in trees represents a major problem for the Forest Industries across Europe. In the sawmilling industry, it contributes to the down grading of battens through a reduction in stiffness and an increase in twist and distortion. Although sawmills can observe the negative consequences of compression wood on timber, they are not well equipped to identify it and thus to minimize these consequences. With several sawmills being equipped with x-ray scanners for logs, the technology is now available; it is the algorithms to recognise compression which are missing. A promising approach would be to be able to link a model of 'normal' wood properties inside logs to images obtained from an x-ray scanner. Areas of unexpectedly high density could be identified as compression wood and the sawing could thus be optimised to take into account the presence of compression wood in the log.

Justification: The results of this research would provide a leap forward in the optimisation of sawing patterns. Instead of simply taking the external shape of the logs and, in some cases, the location of knots, sawing would be optimized according also to the presence of compression wood, a major determinant of timber quality. Because this research would use existing technology, any improvement in the sawing optimization process could directly improve industrial competitiveness. The potential benefits for the sawmilling industry could in turn contribute to the socio-economic well being of communities which depend on the forestry sector (particularly of rural communities across Europe).

European relevance and collaboration: A Framework 6 EU project on compression wood has recently been completed. This project has considerably increased the amount of fundamental knowledge and expertise on compression wood held across Europe. Now would be an ideal time to use this expertise in order to develop new practical applications. The following institutes could have a key role in the implementation of this research: Forest Research (UK), Centre for Ecology and Hydrology (UK), University of Freiburg (Germany), Institut fur Waldwachstum (Germany), INRA Nancy (France), Swedish University of Agricultural Sciences (Sweden), University of Joensuu (Finland), University of Florence (Italy), Chalmers University (Sweden), Building Research Establishment (UK).

3.1.30 Efficient measurement methods for properties of wood and wood cells

Positioning: Basic

Short Description: Access to efficient methods for measurement of properties of wood and wood cells is a key factor for research and development as well as for efficient operation in forestry and industry. In some fundamental studies, efficiency may not be crucial, but quite often it is, in order to obtain representative in research of for use in operation. Methods are needed for different levels of detail, but detail is sometimes traded for efficiency. When new methods are made available, major steps forward are often possible, first in R&D, then in applications. Examples of this are the effects on research at the introduction into wood research of computer tomography, spectroscopic methods and the SilviScan technology. These techniques have large potentials for further development. In the project, existing techniques are further developed for new applications (new properties, new wood species, improved detail, higher capacity, etc.) and new techniques are assessed. This development is boosted by supporting the involvement in the research teams of guest researchers with special expertise for development of new functionalities and support to tests of techniques in new research applications. Workshops are arranged to widen the awareness of existing methods and resources, to enhance innovativeness and efficiency in research.

Justification: The project will make possible investigations of new aspects of wood and wood cells with efficiency high enough to allow the study of representative sets of materials. This will also open up for the development of models and other sub-results needed for applications. Other project results will make possible studies with a higher level of detail to allow a better understanding of phenomena behind the properties investigated, growth processes in wood formation, etc. This will also open up for a more efficient exploitation of the properties of wood and wood cells in product development, new and improved products, reduced use of materials, chemicals and energy in the production processes. In the end, this will contribute to increased competitiveness in industrial and forestry, better products for the end-users and reduced environment load.

European relevance and collaboration: The building and operation of equipments of the types mentioned above are often demanding, regarding intellectual as well as financial resources. This is also true for the continuous development of new applications after the initial phase. A wide range of competences are needed regarding the materials studied, measurement techniques, computer control etc. Considering the investments needed, it is very important to maximize the benefits from equipment like these by achieving an efficient utilization and wide application of each system. The addition of new functionalities to existing systems, use of guest researchers in this development and access to new measurement data from the systems for other research groups are good ways of maximizing the benefits. The development of methods will be basic research. The results from the new measurements will, however, also be used for applications.

3.1.31 NIRS for improved process and products

Positioning: Applied

Short Description: The research will focus on vibrational spectroscopy in order to develop systems and methodologies for better selection, conversion and optmisation of wood products.The aim is to provide a better understanding and mastering of these methods applied to wood and wood products.The research could be developped in the field of tree breeding program and in industry for grading purposes (mechanical, durability, ...).

Justification: Vibrational spectroscopy like NIRS is a well known method for products characterization and ptimisation in agro-industry and chemical industry. In wood-forest chain this kind of method is not fully used bescause of a lack of knowledge and specific devices and methodologies. The use of such methods could contribute to a better use of wood and wood products to compete with other engineering materials. For instance, the assessment of natural durabilty, which a complexe, tedious and expansive characteristic to measure could have a positive impact on the use of biocide and wood.

European relevance and collaboration: Many forest and forest products laboratories have competences in this field. Many companies are interested by this kind of methodology. The european forest-wood chain, like in agricultural field, could benefit of such reseach and development activities. Several COST groups could have a key role.

3.1.32 Characterizing stem wood and fibre properties at forest planning (corr.vers)

Positioning: Applied

Short Description: New technology for measuring and characterising wood by efficient methods for forest inventory have a large potential to improve planning of forest operations. It supports development of optimized cutting plans, with respect to customers demands, economic and environmental cost/benefit analyses, demarcation of assortments and wood classes, destination, harvesting plans and logistics. Long term strategies for efficient, valuable and environmentally sound wood supply would also be supported. The planning perspective should be a full integration of forest operations into different industrial processes. This requires development of: • Methods to gather key information like breast height diameter, height and age of trees, frequency of damaged trees etc... • Models for predicting stem, log and fibre properties. • Decision support systems combining characterized wood properties, customer's demands and efficient logistics maximizing the net-value of the sum of all the industrial value chains that are to be concurrently served. Methods for data acquisition could be developed by testing different existing techniques (remote sensing, laser, NIR, callipering, image analyses etc.). "New techniques" could be also tested. Development of models could be based on existing databases and field studies. Decision support systems should be built on simulation techniques and algorithms for optimization.

Justification: There are large economic and environmental potentials in a consistent, reliable, well defined and cost-effective selection and supply of wood adapted to different products and processes. Wood supplies integrated into different products have the potential to improve production efficiency and to increase essential quality properties of final products. Development of measurement systems and models predicting stem wood and fibre properties of industrial relevance are most important issues to achieve real improvements in the forestry-wood chain. For example, the numbers of approved units of a product per m³ of wood raw material could be raised and/or higher product quality and sharpened standards for structural timber, paper products etc… Lower costs and higher revenues and less emissions, at the same time meeting customers demands will considerably increase competitiveness of wood and fibre based products. This will increase the use of environmentally sound wood and fibre based products of gain for the whole society. Preconditions: Use of existing knowledge, adaptation of inventory and planning systems. Use of standard information for forest planning.

European relevance and collaboration: European relevance and collaboration: The markets for forest products and timber are international. Common requirements for information in planning systems would improve the market for development of affordable planning systems and methods for data acquisition. Possible partners Skogforsk, SP Trätek/LTU, STFI, SLU, Sweden, Metla, VTT, University of Joensuu, Helsinki, Tampere, Metsäteho, Finland, Skogforsk NO, NTI, Norway, AFOCEL and INRA, France, Forestry Commission, UK, KVL Denmark, Institut für Bodenkultur

Austria, FOBAWI Germany. Manufactories of systems for planning of wood supply, forest inventories etc...

3.1.33 Wood properties for planning based on high resolution remote sensing

Positioning: Applied

Short Description: The aim of this research is to develop methods and models for the estimation of external wood property parameters needed in forest planning. The research combines expert knowledge on wood science (selection of external wood property parameters), forest inventory (sampling schemes and calculation models) and forest planning (integration of results with practical planning applications) with most up-to-date high resolution remote sensing technology such as laser scanning and digital aerial photographs.

Justification: This research creates a scalable and cost effective inventory system producing more detailed and accurate wood quality data with less costs than traditional field systems. When integrated with planning systems the inventory system produces more applicable information on wood raw material for wood purchasing and forest management decisions, thus, facilitating better allocation of raw material and more effective management.

European relevance and collaboration: The inventory system based on high-resolution remote sensing is more generic than traditional field based systems and, therefore, the general framework for the system can be developed in the collaboration of European research groups consisting of experts in remote sensing technology, wood science, forest inventory and forest planning.

3.1.34 Understanding wood as a composite material on the supramolecular level

Positioning: Basic

Short Description: Wood is a biomaterial with a highly complex supramolecular structure. The spacial organisation of the wood cell wall polymers cellulose, hemicellulose and lignin is far from completely resolved. This is despite the fact that the mechanical properties of wood are based on the supramolecular structure. Wood, like other composite materials, gets its overall mechanical properties from the interactions between the single composites. Recently it was shown that certain wood tissues exhibit a mechanical behaviour unexplainable by existing material theories. To understand the mechanisms within the wood cell walls on the molecular level, the spacial arrangement of the three components is essential. Most of the actual knowledge on the supramolecular structure of wood cell walls dates back 50 years. Recent developments in analytical techniques offer now the possibility to gain a deeper insight into the supramolecular organisation of wood cell walls. Promising techniques employed to solve the above mentioned questions are high-resolution x-ray scattering, solid-state NMR spectroscopy, chemical force microscopy, in vitro wood tissue systems and antibody staining.

Justification: Knowing the supramolecular architecture of wood cell walls and understanding its molecular mechanics could have an impact on the forestry and wood processing industry as well as the industry dealing with engineered composite materials. The forestry sector would get better guidance on how to improve their growing stock in terms of wood quality by breeding programs or genetic engineering. Concerning the wood processing industry, creep, wood drying, impregnating, heat treatment as well as steam bending will benefit from the knowledge of the supramolecular wood architecture. Furthermore new wood materials are thinkable, e.g. ’flexible’ wood. Finally understanding the molecular mechanics of wood bears the potential to mimic them and to manufacture new types of engineered composite materials. Engineers are always looking out for new materials to meet their requirements. The EU faces tough international competition in the wood processing industry sector especially from countries of the southern hemisphere. Their forestry is much more based on plantations of fast growing tree species suitable for wood quality improvements. To compete the EU needs to invest in research of wood quality.

European relevance and collaboration: Because wood is a very complex material a range of sophisticated high-end analytical techniques have to be applied in order to get a comprehensive picture of the supramolecular architecture of wood cell walls. No single research group has the personal expertise and instrumentation resources to exploit all possibilities. Therefore an international collaboration is required. European research groups, currently working on these topics include among others STFI-Packforsk (L. Salmén), MPI Colloids and Interfaces (P. Fratzl), EPF-Lausanne (P. Navi), INRA (J.-M. Leban).

Sub-area 3.2 Tree breeding using traditional techniques or forest biotechnology

3.2.1 Breeding of a multiclonal variety of aspen trees

Positioning: Applied

Short Description: Superior aspen trees should be selected from an existing stock of breeding material of the former research instiute of fast growing tree species in Hesse. They should be cloned by means of shoot tip culture and approved for trade and registered according to the OECD-Scheme or Council Directive 66/404/EEC respectively the relevant regulations on forest productive material in Europe. Each clone of the multiclonal variety should be fingerprinted in order to control the clonal identity and composition of the released material later on.

Justification: Aspen wood could be produced not only in the forests but also on former agricultural land. It is valued by the paper industry because of its low lignin content and high fibre quality. Aspen wood could be produced in short rotation forestry and could be utilized in energy producing facilities.

European relevance and collaboration: A multiclonal variety of aspen trees could be used in various european countries (north part of Europe including Russia). In order to convince farmers and foresters of its value it would be necessary to establish demonstration plantations in each country.

3.2.2 Indirect evaluation of natural durability of wood for genetic studies

Positioning: Applied

Short Description: Natural durability (decay resistance) is traditionally evaluated through standard laboratory methods (EN350-1). These 'biological' methods are destructive and time-consuming and their reliability with regards to within-tree variability requires large number of samples to be tested per individual tree. Clearly, they are not suited for genetic studies where large number of genotypes and individual trees/ genotype have to been assessed. Non-destructive indirect methods are needed. Evaluation of this property through decay test on increment cores is a possibility but the best promises are offered by biochemical analysis of extractives content of wood (both quantitative and qualitative) in relation with the development of NIR'S spectroscopy calibration models. Recent models developed on Larix in a concerted EU project (ended in 2002) seem promising but they still need validation. Very original genetic material (intra/interspecific diallel designs) has been developed and could be used: i) to study the genetic determinism of this property, ii) evaluate the possibility to predict it at an early stage and iii) estimate breeding possibilities for this trait in relation with other growth and wood properties. Larch and Douglas-fir are proposed as model species for that study.

Justification: Two major issues are expected from this research: the first one aims at providing indirect, non-destructive and reliable criteria to breeders for routinely assessing natural durability of heartwood and to confirm breeding and selection possibilities for this important trait (level of genetic variability, stability over time, etc). Among wood properties to be genetically improved, natural durability is a good candidate for species like larch and douglas-fir intensively used in wood construction (structure) including outdoor uses. A large genetic variability among populations of larch for heartwood content and decay resistance has been recently evidenced and this information is an encouragement to proceed further. The second one is of high importance among wood engineers, architects and the wood industry. While there is an obvious wish -for example for Larix in the Alps- to include more and more non-chemically treated wood in buildings and in particular for outdoor uses, there is some justified fear not to get the right highly durable wood resource. Based on results from this proposal, two approaches could be then suggested according to structure of genetic variation: geographic zonation of stands or automatic individual timber assessment through development of specific equipment.

European relevance and collaboration: Douglas fir and Larch are two fast growing species of high national or regional economic importance in western and central Europe. Larch in particular, but also Douglas-fir produces large amount of heartwood and this from very early stages (5 yrs) on. This allows particularly short-rotation forestry with high value timber and high economic returns. Heartwood formation is under influence of complex environmental and genetic determinants which are far from being fully understood. A multidisciplinary approach implying physiologists, geneticists, biochemists and wood technologists as well as breeders and silviculturists is needed and expertise is scattered in several European labs. Key groups to be involved in this project

could include (non-restrictive list) teams from CNR (Firenze, I), BOKU (Wien, A), CIRAD (Montpellier, F), IICT (P), INRA (Orléans, F), Afocel (F), CTBA (F).

3.2.3 Improved flowering competence and capacity in Norway spruce (Picea abies)..

Positioning: Applied

Short Description: Norway spruce is the most important coniferous industrial species in Europe. Tree improvement technology is well developed for the species. Because of the species late and irregular flowering the implementation of tree improvement is however much held up. A number of treatment should be tested for their flowering stimulation effects: - Hormonal treatments with gibberellins (particularly GA4 and GA7) - Grafting of young tree material into older trees (top-working) - Giving extra light treatments - Partial root or stem pruning - Heat treatments - Testing of new flowering hormones recently developed through biotechnology - Etc. Treatments should be evaluated both out-doors and in green houses. Swedish tree improvement experts have considerable experience of working with the species.

Justification: Better control of flowering would significantly improve the effects of genetical improvement in the species, which is today held up because of the species irregular and poor flowering. With regular flowering spruce productivity can be significant increased (at least 0.5 % annually). While a rich seed production makes plantation forestry more economical it is not a prerequisite for planting the species commercially, since vegetative propagation technology is well developed. Improved spruce yield is of key importance to its use as a European industrial plantation species and heavily influences the economy of European forestry.

European relevance and collaboration: Norway spuce in the major industrial plantation species in northern and eastern Europe. It provides an excellent saw timber and is a major pulp wood species on more fertile sites. Norway spruce also provides large amounts of bio-fuel. Flowering studies in Norway spruce should be of great importance to most research institutes in the area that are involved with tree improvement of the species.

3.2.4 Genetic quality control of European forestry plants

Positioning: Applied

Short Description: The goal of the project is to optimize the genetic quality of the forestry plants from important seed sources which have been improved by forest tree breeding. The optimization is made through applying modern DNA techniques for quality control. The project should mainly apply microsatellites (Simple sequence repeats) which is the most powerful type of molecular markers for this type of analyses, since they are capable of making 'genetic fingerprints' of individuals. By comparing genetic fingerprints from germinated seeds from the seed crops and the clones which is contained in the orchard, it is possible to identify which clones are the parents (both fathers and mothers) to the seeds (paternity analysis). Or whether there is some pollination from outside the seed orchard. To do this, two prerequisites should be fulfilled. First, microsatellites should be developed for the species which are of interest. If they are not developed, they can in some instances be 'transferred' from nearby related species (e.g. from one Pinus species to Pinus another). Second, there should be the know-how and relevant laboratories to do these analyses.

Justification: Target research related to breeding and seed source management have resulted in genetic improved plant material for the forestry sector in the last decades. Focus for most species has been on health and timber quality. Commercial utilization of this genetic improved material is mainly based on establishment and use of clonal seed orchards (CSO's). CSO's has globally shown to be the most efficient way to produce genetically improved seed for forestry plants. Experience shows, however, that it is valuable to make a genetic quality control of seeds from seed orchards since there are some circumstances which can not be controlled by the seed producers. The four most important factors in this context are (i) check of the clonal identities (=check whether the correct clones have been grafted), (ii) the degree of pollen coming from outside the seed orchards (alien pollination), (iii) the relative contribution from the clones to the seed crop and, for some species, (iv) the degree of hybridization with unwished species. If there for example is a large pollination from outside the seed orchard, the genetic gain transmitted to the seed crop will not be so high as initially expected. Likewise, if the relative contribution to the seed crop from the different clones is highly skewed, the genetic gain and diversity in the seed crop will not be as predicted by traditional breeding theory.

European relevance and collaboration: Large resources have been used in various European countries to obtain genetically improved plant material through forest tree improvement and related research. The seed orchards is the means by which these improvement efforts should be utilized in the real life forestry. Biotechnology is capital and knowledge intensive, and international collaboration is therefore highly desirable. The species' of interest may differ from country to country, but the methodical issues are the same. Several research groups in Europe, e.g. in Sweden, Finland, France and Denmark works with these issues, and each of these could enter into this research project.

3.2.5 Genetic variation of wood properties incuding measurement techniques

Positioning: Applied

Short Description: Traditional tree breeding has been very successful in improving tree growth. Today improved conifer material grows 25-30% better than unimproved. However, little has been done to improve the wood quality i.e. improve traits that affect the quality of the final products. To come forward in this area research about the genetic variation of wood quality traits are needed. Approaches combining quantitative genetics, which is the theory that traditional tree breeding relies on, with molecular genetics, are interesting. Existing field trials with genetic tests (progeny and clonal tests) would be valuable for such studies. An important and useful tool for the studies as well in practical breeding would be access to rapid, non-destructive measurement technique as a large number of trees often is needed to be measured. Development of such technique should be given priority.

Justification: With more knowledge in this area and access to non-destructive measurement techniques it would be possible to genetically improve the wood quality. For instance, 5-10% of the genotypes produce wood that are not possible to use for construction purposes due to low shape stability. If such genotypes could be identified and culled within the tree breeding it would reduce costs for the sawmill industry and thereby increase the value of the growing stock.

European relevance and collaboration: Tree breeding is carried out in many of the European countries so there is clearly a common interest. It could be collaborative work between researchers working with traditional forest genetics and between researchers doing molecular genetics on forest trees as well as tree breeders.

3.2.6 Breeding strategies and methods for improved quality of european hardwoods

Positioning: Applied

Short Description: The research issue is about ways to improve wood quality of valuable European broadleaved trees by application of traditional tree improvement techniques. The idea is to use the relative few and scattered progeny trials in Europe to estimate key genetic parameters related to wood quality. Selected trees, progeny trials and clonal seed orchards have been established in several countries but we trust that much more genetic insight and understanding can be extracted from these trials. An important part of this task will be to test and adapt techniques from conifer breeding to breeding of broadleved species such as oaks (Quercus petraea and Q. robur), beech (Fagus sylvatica) and Ash (Fraxinus exelsior). Research will include wood analysis, quantitative approches to estimation of genetic and environmental components of variation, estimation of heritabilities, gxe interactions and potetial gains.

Justification: A number of wood quality parameter has been shown to have high genetic heritability which means they can be improved substantially through selection and breeding. The relative high degree of genetic variation in wood quality traits is probably due to the fact that these traits are under relative mild natural selection compared to fitness traits such as height and/or health which allows maintenance of large genetic variation suitable for tree improvement. In order word: it should me fairly easy to improve the quality of planted trees through breeding. However, until now most tree breeding work has been done on conifers and at present tree breeders therefore have quite limited knowledge about genetic parameters in key European broadleaves such as oaks (Quercus petraea and Q. robur), beech (Fagus sylvatica) and Ash (Fraxinus exelsior). Breeding of these broadleaved species are also complicated by more difficult multiplication due to the size of the seed, slower testing (slower growth) and often requirement for high level of genetic diversity. These features challenge traditional clonal seed orchard approaches developed and implemented for conifers, but they do not mean that broadleaved cannot be improved trough selection and breeding. Only, research and development that can lead to efficient integrated improvement, multiplication and deployment strategies on European broadleaved species are required. Logs of broadleaved trees are of large economic importance, and improved stem and wood quality will have important derived effects of the very important wood manufacture industry. Development of germplasm that can produce genetically diverse, healthy broadleaved trees with good stem form and high wood quality, will by it self increase the use of native broadleaved species as alternative to exotic conifers on appropriate sites. This will be considered an social and ecological benefit in many regions.

European relevance and collaboration: Selected trees, progeny trials and clonal seed orchards for broadleaved species are scattered amongst European countries, and experience with breeding for wood quality in broadleaved are limited. A joint, coordinated effort will therefore be of major importance in lifting this task. All involved countries have research groups that can be involved in the task.

3.2.7 Breeding for improved timber quality in Norway spruce

Positioning: Applied

Short Description: So far, the objectives in breeding of Norway spruce in the Nordic countries have been focused on adaptive traits, volume production and external stem traits. Now, progeny trials have attained an age when it is possible to put more emphasis on wood quality traits. Initial studies have revealed a substantial genetic variation in such traits. This proposal contains development of techniques to screen for wood quality traits such as spiral grain, wood density and microfibril angle in cooperation between wood scientists and geneticists. Such measurements will be done in a number of spruce progeny tests available in Norway, Sweden, Denmark and Finland, and, if feasible, on parental clones in seed orchards. It will be important to determine the ages when selection can be safely done and characterise correlation patterns between wood quality and other important traits. On this basis, breeding strategies that will improve the quality and economic value of the future forest will be developed and introduced into practical breeding programs.

Justification: The dominating part of the Nordic saw timber is used for structural purposes, which requires sufficient shape stability, strength and stiffness properties. Higher demands for economic returns from the forest sector may imply that forest stands will have to be harvested at earlier ages. This will results in a higher proportion of juvenile wood which is inferior and highly variable in important wood quality characteristics. Genetic improvement of these traits will both improve the average quality and make the raw material from the forest more homogeneous. This will improve its economic value both for the forest owner and for the forest industry in general. A precondition is that future forest products will come from planted forests and that high quality will be valued.

European relevance and collaboration: Breeding of Norway spruce has a high priority, particularly in Norway, Sweden and Finland, and several of the breeding populations in these countries can with large benefits be combined. Different institutions, both in these countries and in Denmark, Germany and France have developed advanced techniques for measuring wood quality properties (e.g. SilviScan at STFI-Packforsk, Sweden). The breeding institutions will benefit from collaboration with the woods scientists at these institutes. Actual partners are METLA, Finland; Skogforsk and STFI-Packforsk, Sweden; Skogforsk, and NTI, Norway; KVL, Danmark; INRA, France; BFH, Germany.

3.2.8 Wavy grain wood for high value uses

Positioning: Applied

Short Description: In many tree species certain patterns in the wood attract very high market demand and prices. In the case of sycamore (Acer pseudoplatanus) the " wavy grain " wood is sought for musical instruments and for high value furniture. The physical structure of such wood is poorly understood. The genetic and physiological basis is not known and the trees with such patterns should be conserved propagated and made available for deployment into forests.

Justification: Knowing the physical structure of wavy grain wood may indicate the physiological processes of this type of wood formation. Breeding and genetic modification in trees now offers possibilities to change the chemical and physical properties of wood and genes may be found affecting the process of wavy grain formation. Conservation and propagation of such trees should give an additional option to foresters to use trees which carry these traits and so provide the growers with improved income potential as well as increasing the supply of high value wood in Europe for developing the elite furniture markets. It is necessary to characterise the physical, physiological and genetic basis of these types of wavy grain woods which exist in several tree species in European hardwoods and this would facilitate breeders and geneticists to develop breeding lines in the future.

European relevance and collaboration: Wavy grain wood patterns occur in several hardwood species including Acer Betula and Fraxinus-- they may have a common developmental and genetic origin. However information is very scarce. The physical and chemical structures of wavy grin wood is not fully characterised. In some countries steps have been taken to propagate such trees and an assessment of the wood quality after several years of growth would now be desirable. Similarly it is desirable to share information and experimental methods for the conservation and propagation of the unique germplasm that is available in different countries.

3.2.9 Influence of genotype and environment on forest tree's cambial activity

Positioning: Basic

Short Description: Cambial activity, and therefore wood characteristics, depend on the genome of the tree, its environment and the interaction between both. Among the most important environmental factors are the exceptional climatic events, namely heat and drought, for which an increasing frequency is expected at short or middle term in the frame of the climate change. In view to predict the evolution of wood properties in this context, we propose to investigate - How do react species, provenances or other forest reproductive material presently planted. - What are the consequences of the observed variability of the tree response to a climatic event on the wood quantity and quality. - What could be the consequences, at short middle or long term, of repeated unusual climatic events on the wood material produced. Techniques now exist, which enable us to collect microdensitometric and anatomic profiles on a large number of wood samples. These profiles already proved to be excellent predictor of the main wood properties and are seeked to predict adaptive traits. Moreover, through molecular techniques, it is possible to screen the most pertinent genes responsible of the cambial activity as well as their polymorphism within tree populations. The present project will rely on data from the exceptional existing European experimental network of forest tree genetic tests.

Justification: The fast growing tree species planted today at large scales in Europe require large water resources. The main outcome of this project will be a set of results related to the consequences of a predicted or possible increment in aridness on forest survival, growth and wood formation in several important forest species: Norway spruce, Douglas-fir, Scots pine, Larch, Poplars. We endorse the idea that the phenotypic and genetic variability related to the wood anatomy profiles can be correlated to the tree response to drought. Thus we can make inference about the economic impact of drought to the quantity and the quality of the wood production. Economically important traits can be associated with the adaptive traits which measurement constitutes the core of this study. Hence it is possible to provide relevant information to tree breeding programs, taking into account at the same time ecological and economical aspects. Also it is also possible to model the respective weights of these two fundamental aspects. The results of the studies can also provide methods and, sometimes, direct information useful for the restoration of forest ecosystems that suffered in the past from severe aridness episodes.

European relevance and collaboration: Since several decades under the auspices of IUFRO and former EU projects, hundreds of genetic tests have been planted all over Europe in a concerted way for various forest tree species: Douglas-fir, Norway Spruce, Larch, Scots Pine, Ash, Poplar. They cover today several hundreds of ha. Some genotypes are planted far beyond their native origin in environments, which already mimic the climate foreseen for the end of the present century. These networks have no equivalent elsewhere in the world. On the other hand, a network of research teams, linked in previous EU projects, can offer complementary expertises in the field of wood

properties evaluation: INRA Orleans (France), CNR Florence (Italy), Univ. of Wales (UK), IICT & ISA Lisbon (Portugal), BOKU Vienna (Austria), Skogforsk (Sweden).

3.2.10 Quality breeding

Positioning: Basic

Short Description: Identification of most interesting wood property traits for breeding, evaluation of best methods for large scale screening of wood property, estimation of the amount of natural genetic variation in traits, identification of genes behind natural genetic variation, assesment of costs and benefits gained by traditional breeding, by molecular breeding using natural genetic variation, or by GM-techniques.

Justification: Quality of wood highly important for industry, e.g, even small decrease in lignin concentration can cause substantial savings in processes.

European relevance and collaboration: Europe has excellent research infrastructure for research in the field, e.g., recently established EU-funded NoE EVOLTREE and research infrastructure (CA) TREEBREEDEX.

3.2.11 Causes for wavy grain wood structures in broad-leaved trees

Positioning: Basic

Short Description: Wavy grain wood structures are rare within a certain tree species, but may occur among different broad-leafed trees. They are often responsible for the high value of this wood.Wavy grain wood e.g. in sycamore (Acer pseudoplatanus) is of high economic value, although the formation of this wood structure and the heritability is still poorly understood. Therefore, based on conservation of selected tress by grafting, methods of propagation should be elaborated aimed at the development of detection methods and at the investigation formation of this wood pattern formation on different levels

Justification: From the occurrence of this wood pattern in different tree species it can be concluded that there is a common ground in woody plants concerning the formation of these structures. Because this wood pattern is a value-related criteria of a high wood quality it would be interesting to study the causes and expression of this trait on physiological as well as on molecular level. Furthermore the early detection of desirable wood structures with molecular markers and propagation of such a material would allow the use for foresters and landowners for a sustainable production.

European relevance and collaboration: Different European research programmes have already concentrated on wood quality and the elaboration of markers which are related to wood quality. The existing knowlegde concerning the selection and first steps to conserve wavy grain material in different European countries should lead to a network which allows to combine the present knowledge in Europe. The knowledge of genetic, physiological and physical background of such a phenomenon is the basal necessity for the understanding as well as for the use of developmental processes in wood formation for applied tree breeding in future.

3.2.12 Use of DNA markers in early screening for wood properties

Positioning: Applied

Short Description: This involves the use of DNA markers to select genotypes with particularly favourable wood characteristics such as wood density or microfibril angle. It can be studied by establishment of suitable, full-sib, field based trials from which phenotypic traits can be associated with molecular markers. We have taken the first step of establishing suitable Sitka spruce (Picea sitchensis)field trails with this objective in mind but funding is required to find the markers which are associated with key traits such as wood density.

Justification: If this technology was found to work and associations of marker and trait were robust across families and environments then genetic screening would become much quicker and cheaper than the traditional field based methods. Once seedling genotypes had been identified in the laboratory the next step would be to make many copies for industry using the latest somatic embryogenesis techniques in conjunction with cryopreservation. The benefit would be more genetic gain in wood quality traits reaching the field sooner. The improvement in the quality and quantity of timber coming from a given area of land will free-up more land for other non-timber uses.

European relevance and collaboration: Several Canadian research institutes are currently working in this field with pines and spruces under the umbrella of Genome Canada. Although several European institutes are also involved in this field of study (INRA (France), METLA (Finland), the Federal Research Centre (Germany)) they are not receiving such a high level of financial support as the Canadian laboratories. Also the European effort lacks the coordination present in Canada. Despite the fact that different institutes vary in their species of interest, any technological breakthroughs will be applicable across species. A coordinated European approach will ensure that such technological transfer occurs thus optimising the use of limited resources.

3.2.13 Researches of Norway spruce, Silver fir and Larch genetic diversity for conservation the forest genetic resources in Europe

Positioning: Applied

Short Description: These researches will reveal the intraspecific genetic diversity of the spruce, fir and larch for the purpose of identifying forest genetic resources in Europe. The study of species'genetic diversity will be accomplished on two levels: quantitative genetic studies and molecular genetic studies. The researches will be carried out in experimental trials settled in many European countries: provenance comparative trials, progeny trials and seed orchards. The necessary information refers to: the tested provenances, experimental designs, results obtained so far, etc.

Justification: By these research is tested the genetic value of studied provenances in comparative trials or the plus trees in seed orchards. According to the OECD Scheme for the certification of forest reproductive materials, the most valuable provenances or plus trees represent tested seeds. These genofunds or genotypes are forest genetic resources and they must be identified and preserved in situ. On the other hand, the researches will provide information about: genetic diversity on the molecular level, the genetic structure of the studied populations, genetic inheritance of growing and adaptive traits, GxE interaction, age to age correlations, stability, early tests, etc.

European relevance and collaboration: In most European countries there are many experimental trials: IUFRO experiments, many national experiments and many seeds orchards as well.They reached the age when results are more precis and more definite. It is necessary to have a comprehensive synthesis of the results obtained so far during the research, about the genetic diversity of these three important forest species. It is the first level of biodiversity conservation, in general, and of forest resources, in particular. The results will be used as a background for the species breeding strategy and for advance breeding generations.

3.2.14 Early selection of heartwood decay resistance by genetic markers

Positioning: Basic

Short Description: There is wide variation in natural decay resistance of Scots pine (Pinus sylvestris L.) heartwood. Exploitation of the variation by the methods of tree breeding is demanding because of the late age of the heartwood formation. Thus, an early testing method is deeply needed. The method could be based on recognising the genes that explain most of the variation found in decay resistance. In Scots pine, the most important decay resistance-related phenolic compounds are stilbenes (pinosylvin and its derivatives). STS gene family (syn. PST) controls their synthesis. STS gene expression is known to have an important role in the synthesis of both heartwood and stress-induced production of pinosylvin. Our interest is to study associations between genetic variation within STS gene family and in the decay resistance of heartwood timber. The study material is composed of a large number of progenies from thoroughly studied genotypes of Scots pine. Quantity of stilbenes could be measured from the heartwood of adult trees and from seedlings exposed various stress factors. We already have an abundant collection of seeds belonging to more than 400 families to be included into the study.

Justification: The goal is to find methods to predict decay resistance of heartwood timber. This kind of research gives tools to produce more uniform and predicted quality of solid wood. An early testing method would allow the selection of forest regeneration material that will produce naturally durable heartwood. Preference for naturally durable timber assortments partly arises from the restrictions set to the use of synthetic wood preservation chemicals. Naturally decay resistant wood is not toxic waste and it can be returned to the cycles in the nature. Industry and the consumers should be given options covering the range of naturally decay resistant timber assortments and the ranges of permitted wood preservation methodologies. The proposed research should be done today because it gives a possibility to a broader spectrum of approaches in future considering the durability and marketing of wooden products. If this early testing method works with Scots pine, it will work with other tree species as well. Moreover, the results will most probably give rise to new unforeseen ideas and applications.

European relevance and collaboration: To get reliable and applicable results this research needs large sample sizes and a spectrum of experiments for studying the effects of different stress factors. It would be highly reasonable to take advantage of the already existing knowledge and established practices in stress experiments. It would save time and resources. The difficulty is that finding the collaborators working under different disciplines is quite a demanding task. In the context of stress experiments of Scots pine, the knowledge on stress experiment resides in Europe.

3.2.15 Genetic variation of spiral grain in Sitka and Norway spruce

Positioning: Applied

Short Description: Both Norway spruce, but in particular Sitka spruce timber is often downgraded due to problems with twist mainly caused by spiral grain. Normally, spiral grain is increasing until ring 10-20 and then it decrease. Studies of spiral grain in the first 5-10 rings have shown that the trait is highly heritable and only moderately correlated with growth. Still, it is not known if fast growing trees tend to maintain a high level of spiral grain and this is crucial to know in breeding programs for the species. This project is aiming at studying the genetic variation of spiral grain with age and the genetic and phenotypic correlation of spiral grain with growth based on measurements in older progeny tests and clonal trials. Spiral grain is measured on stem discs or wood cores. Additionally, there is the possibility to measure the spiral grain at the surface of trees in older progeny tests and clonal tests measured some years ago to establish age-age correlations and correlations with growth.

Justification: The results from the project would improve the chances to reduce spiral grain through breeding and significantly improve the economy of sawmills by reducing the downgrading and rejection of cut and kiln dried timber due to twist. Additionally, the project will give some answers on how forest management might influence the degree of spiral grain and if it is possible by some easy means (measure on the surface of stems) to reject timber with pronounced spiral grain before manufacturing costs (cutting and drying). The results will not have any socio-economic or environmental impacts.

European relevance and collaboration: Both species are widely used in whole Europe with breeding programs in United Kingdom, Sweden, Norway, Finland, France and Denmark. Therefore, the issue is suitable for collaborative research activities. Research groups that could have a key role for the project are Forestry Commision, Skogforsk, Metla and INRA.

3.2.16 Maximising gain from breeding programmes by applying clonal forestry

Positioning: Applied

Short Description: The techniques of cryopreservation and somatic embryogenesis are not new in crop breeding, but are still at a developmental stage in tree breeding. More research is still required in making these processes cost effective if clonal forestry of Sitka spruce is to become cost effective. Immature seed need to be collected from a number of control-pollinated full-sib crosses and studies carried out on the most efficient protocols to encourage initiation and maturation of somatic embryos.

Justification: Results from this study will allow the cost-effective mass-production of genotypes selected for specific wood characteristics such as high timber strength combined with good straightness and high growth rate. Material entering sawmills could be far more uniform removing one of the traditional barriers to the use of wood relative to other construction materials - its variability - opening up no markets to a more environmentally aware society.

European relevance and collaboration: Many institutes across Europe are interested in developing these clonal forestry techniques for their particular species of interest. A more collaborative approach will enable more efficient sharing of knowledge across the research institutes. We would like to work with Coillte (Ireland), Denmark, Skogforsk (Sweden) and INRA (France) in developing these techniques

3.2.17 Breeding for quality

Positioning: Applied

Short Description: It is important to identify the future needs for wood raw material properties and take them into account in tree breeding. Possibilities to increase tree resistance of tailor fibre properties can be possible by combining molecular biology and traditional tree breeding.

Justification: New molecular techniques can help to select seed and seedling material for forest regeneration for future needs. Industry may be sure to have desired raw material to be available and environmental issues like climate change, disease and storm resistance can be taken into account.

European relevance and collaboration: It is an european issue to assure suitable raw material properties but also forest health and biodiversity in the future forests. Many laboratories work with the issue,

3.2.18 Clonal Forestry

Positioning: Basic

Short Description: A technique where tested clones could be deployed using the techniques of somatic embryogenesis and cryopreservation following field testing of the clones.

Justification: The technique would produce forests and timber that were higher yielding, more uniform and have characteristics such as high wood density that had been selected for during the tetsing phase.

European relevance and collaboration: The research would be done on Sitka spruce, the major forestry species in the UK and a close relative to Norway spruce, a forest tree species common in Europe. Techniques are interchangeable between the two species.

3.2.19 Designing high value trees

Positioning: Basic

Short Description: The rapid progress in our knowledge about plant genomes, and research technologies for studying the function of genes proteins and metabolites have tremendously increased the potential for plant breeding. Of particular interest for the forestry sector is the sequencing of the poplar genome, and high throughput technologies for functional analysis of poplar genes. The major deliverable from this research theme is the identification of key genes to be used in marker assisted breeding and/or transgene applications. Plant genomics and transcriptome analysis have identified a large number of candidate genes involved in the biosynthesis of the fiber wall. Enzymes and proteins involved in primary wall biosynthesis are critical for fiber length and form, and those involved in secondary wall biosynthesis for fiber chemistry and ultrastructure. The research theme involves analysis of poplar and Arabidopsis mutated in selected candidate genes. Methods involved could be cell biology approaches, global analysis of the transcriptome, metabolome and proteome analysis, microscopy, spectroscopy and spectrometry technologies and mechanical analysis for of the wood. All combined with modelling and a system biology approach. It also requires research on expression and studies of the proteins/enzymes to determine substrate specificity and enzymatic properties. This research theme is connected to 1.5, 3.1 and 3.3.

Justification: This research will result in the design of trees with an increased value. The future need of renewable raw materials will increase, and wood and wood polymers from forest trees are an obvious resource. This will put pressure on our forest ecosystems, which are also needed for environmental and socio-economic purposes. Thus we need to increase wood production. Efficient production of high value trees for high value products will contribute to keep up our competitiveness against wood producing systems in more favourable parts of the world. This research will also result in innovative fiber products using desgned fibers. Fibers can be designed either during production in the tree, or after harvest by enzyme technology using novel enzymes identified in the research.

European relevance and collaboration: Europe has world leading groups in all research fields required for making breakthrough research in this theme. Groups in Sweden, Finland and France have contributed to the establishment of poplar as a model system. Research on cell wall biosynthesis, bioinformatics and enzymology on cell wall enzymes is carried out in many of the European contries. Moreover wood chemistry and wood material science is very strong within the Euoropean community.

3.2.20 Stem cell function during wood development

Positioning: Basic

Short Description: Wood is produced by stem cells that occur as a cylindrical sheet between wood and bark. It is the activity of these cells that controls the rate of wood production. They also initiate the differentiation process related to wood formation, thus determining some aspects of the wood as a raw material. We understand still very little about the molecular control of these stem cells. Some progress has been recently made by gene expression profiling and gene silencing in tree species as well as through genetics in Arabidopsis thaliana, a genetic model for plant developemnt.

Justification: By understanding the molecular control of the stem cell aspect during wood formation, it should become possible to breed tree growth and wood quality. This breeding could be done by the traditional selection, based on the new gene information but without transgenes. Alternative, transgenic methods could be envisioned.

European relevance and collaboration: Europe currently holds the strategic position in this research. Especially researchers in Finland (University of Helsinki, University of Turku) and Sweden (Umeå Plant Science Center).

3.2.21 Use of novel property measurements in genetics and tree breeding

Positioning: Basic

Short Description: There is an increasing activity in the linking of genetic structure with traits. In this work, it is important to be able to search in broad areas of traits, as it is not easy to foresee where links may occur, and to have access to efficient methods. Efficient measurement methods are also needed for early selection of premium plant material in tree improvement programs. With new methods, more traits/properties may be investigated. Two examples from the Wood and Fibre Measurement Centre of STFI-Packforsk: 1) Properties of fibres and vessel elements in different growth rings of hardwoods may be studied with new procedures. It has been used to investigate how properties develop with age/radius for clones of hybrid aspen with different growth rates, offering new possibilities to study variability in and relationships between properties, age-to-age relationships and heritability and to compare plant materials. 2) With detailed data on the radial/time variation from the SilviScan instrument, data on one property may be processed to provide information related to specific years and seasons, when different growth processes are active, offering a broader set of traits in the search for relationships. In the project, these and other novel methods are applied, improved and developed.

Justification: With the application of existing new measurement methods and the development of new methods, more traits which are closer related to growth processes of the trees may be investigated. New properties of wood and wood cells, closer related to issues of industrial importance may be studied. Preferred plant materials can be selected at an earlier age, accelerating the improvement process. Growth and yield will always be important, but with such tools, properties of importance for product quality and production efficiency in the mills could be more emphasized in the development of improved plant materials. This would improve the competitiveness of both industry and forestry. It could also contribute to secure and create job opportunities in forest regions.

European relevance and collaboration: European forestry and industry is facing increasing competition from countries with fast-growing plantation forests, where often opportunities in tree improvement have been applied to improve the wood and fibre resources. There are, however, also in Europe possibilities to gain from these technologies. In the southern parts of Europe, similar schemes are since long applied for Eucalyptus plantations, but there are still potential for further improvements. Other examples are work on Sitka spruce in the British Isles and poplar/hybrid aspen, which may grow very well also in the northern parts of Europe. There are several world leading research groups around Europe in the field. Examples of groups which could contribute with different pieces in a network are SLU/Umeå Plant Science Centre, Univ of Nottingham, CNRS, STFI-Packforsk/Wood and Fibre Measurement Centre, Forest Research Scotland and Instituto Superior de Agronomia. The project is suggested to emphasize the development of methods and to prove their use in a couple of case studies, related for instance to eucalyptus, Sitka spruce and hybrid aspen. From the case studies, there will be only a short step to applications.

3.2.22 Improving technical wood quality

Positioning: Basic

Short Description: The demand on plant resources for technical applications such as fibres, wood, insecticides, waxes, tints as well as energy production is rising world-wide. Raw materials are typically provided by agricultural crops and trees, which have not been specifically bred for these purposes or which are even wild species (trees). Fundamental knowledge about the genetic potential of these resources, the metabolic pathways as well as their regulation leading to the formation of renewable products is scarce. With the availability of whole genome information of important plant model species, the rapid advent of molecular technologies ("omics" and sequencing) and instrumentation, we can now address questions such as: what determines wood and fibre properties and how can we modify them to improve product quality? How can we improve plant traits for energy production? Which molecular markers enable quality assessment for distinct industrial applications? To accommodate the increasing demand for renewable resources, it is necessary to broaden the scientific basis for their biological production, to explore their potential as source for innovative products, e.g., resins, volatiles, oils, etc. and to improve product quality by biotechnological and chemical engineering.

Justification: We would obtain increased knowledge how to modify important technical properties of wood either by classical breeding or by biotechnological approaches. Companies could improve the production of wood product by using less solvents, agressive chemicals and so on. The production would be cheaper and decrease environmental pollution.

European relevance and collaboration: The issue involves expertise in conventional and molecular breeding, as well es technical experitse for wood processing. University Goettingen, (Polle, Finkeldey) Germany, and INRA, France (e.g. Dreyer, Martin, Nancy, Plomion Orleans), University of Antwerp (Ceuleman), Anwerp, University of Southampton, Taylor, UK), Sweetree Sweden, SLU Umea (Sunberg)Sweden, University of Viterbo (Scarascio-Muggnoza, Italy), University of Lisboa, Pereira, Portugal, Pfleiderer (industrial company), GreenTec (SME, germany)

3.2.23 New genetic models of wood formation

Positioning: Basic

Short Description: Wood formation is a developmental process. Historically developmental processes have been most efficiently approached by genetics. The genome of Populus trichocarpa has been recently sequenced and it has become a molecular tree model. However, the problem is that Populus is not a good genetic model because of a long generation time. It is timely to explore the potential of other possible species, perhaps more suitable for genetic analysis than Populus, but that can be analyzed by taking advantage of the Populus genome information. One such possibiliyt is silver birch (Betula pendula), which is monoecious and some lines have a very short generation time.

Justification: In order to establish a new model, the properties for research should be well defined and there should be an international network developing around the model.

European relevance and collaboration: Europe is very competetive in tree genetics. There is good expertise in many countries.

Sub-area 3.3 Factors affecting wood and fibre properties

3.3.1 Anatomical properties in different provenances of pine and spruce

Positioning: Basic

Short Description: The purpose of the study is to investigate anatomical properties in different provenances of pine and spruce. Among important anatomical properties are: fibrilangle, length of fibre, width of fibre, thickness of fibre, content of latewood etc. Additional we need information about suitable sample plots. The study will be based on SilvScan.

Justification: Knowledge affected to wood and fibre properties is of great importance for forestry and forest industry all over Europe. For Pulp Mills will properties like dimension of fibre and content of latewood be important. Regarding to occurrence of cracks in plank and board the fibrilangle is of great importance. The impacts are depended of suitable sample plots in different European countries.

European relevance and collaboration: The investigation will generate new knowledge about wood and fibre properties in different provenances of pine and spruce. For some provenances the study also will show properties connected to grown conditions. The investigation will also be of the outmost importance for tree breeding. Researchers affected to Wood Science and Technology could have a key role in the implementation of this research.

3.3.2 Influence of Site Factors on Wood Quality

Positioning: Applied

Short Description: The research intends to analyse, which site factors concerning chemical soil properties (pH-value, base saturation, nutrient availability), physical properties (substrate, particle size distribution) and stress factors (water scarcity, toxic matter, other extremes) can influence relevant wood quality factors like branchiness, year ring width and facultative heartwood formation. The studies can be carried out along typical site factor gradients in representative regions in Germany concerning the most important and value-differentiated tree species like European beech (Fagus sylvatica), Oak (Quercus petrea and Quercus robur), Scots pine (Pinus sylvestris) and noble hardwoods. As approach, (1) an analysis of existing results indicating the role of different site factors for wood quality will help to develop a decision matrix for the identification of key factors. This analysis will be followed (b) by an empiric analysis of harvesting and timber selling statistics (assortment distribution) in consequently selected test areas. (c) An interdisciplinary investigation of representative test plots including chemical soil analysis, growth and wood quality studies and economic evaluation will test the empiric results in vivo. The investigations can be based substantially on European forest monitoring information (Level-I / Level-II / Forest Focus, ENFIN) and on national and regional forest information systems (e.g. EFICS) and statistics.

Justification: As result, an improved trans-regional decision basis for the production of distinct quality timber is expected. Up to now, knowledge on the back-coupling links between single / combined site factors and wood quality features is restricted on investigations on a regional and local level. The innovation of this approach consists in the possibility to derive, verify, and map value expectancy sites and regions, which can help (a) industry to improve the trans-regional coordination of timber purchase and (b) regional forestry to realize a strategic optimization of tree species choice. (a) + (b) result in a better mutual coordination of the added value from timber production and can contribute to a win-win situation. Furthermore, forest management planning can be supported regarding the realization of environmental and economic goals, when considering e.g. a site factor and wood feature oriented tree species choice for conversion purposes: up to now, the tree species choice for ecological conversion ignores more of less the aspect of later timber marketing. The steering of such a site adapted and regionally defined tree species choice optimization would demand for the definition of “timber quality provenance sites / regions” comparable to genetic provenance regions.

European relevance and collaboration: Timber industry operates on European level, while European forestry is at max dealing on national level, very often however is restricted on a regional and local level. The proposed research issue is apt to bridge the discrepancy of management and operation levels and thus is especially suitable for European collaboration. Furthermore, it can build on preceding European research activities carried out in the 5th and 6th FRP (e.g. COMPRESSIONWOOD, EFORWOOD), which however are more end-product and not primary production oriented. A key role in the proposed research item can be played by respective French

and German working groups, besides research can be based on the network of the IUFRO Working group 5.01.04 (Wood quality modelling).

3.3.3 Short-rotation cropping and juvenile wood and Reaction wood

Positioning: Basic

Short Description: There is an increasing tendency for the planting of fast growing species/genotypes of forest trees in order to permit harvesting after less than thirty years, and occasionally as little as ten years for pulp production. This leads to more efficient production of large amounts of biomass and pulp fibre, but yields timber having low stiffness. The example of Pinus radiata in New Zealand has shown that high density is not necessarily an indicator of good wood quality. Here, trees grown from seed produced by breeding fast-growing and high density trees were expected to produce high volumes of high grade timber on the basis of a thirty to thirty-five year rotation. In fact the proportion of juvenile wood in these trees (typically about 50%) with a high microfibril angle in the tracheid walls meant that the timber had low stiffness and correspondingly low commercial value. Reaction wood is a problem for the timber industry, but like high microfibril angle in juvenile wood it performs an essential role in ensuring the survival of the tree. However, its production is variable and the tendency to overproduction in some species and under conditions of rapid growth seems to have no obvious benefit for the tree, but vastly reduces the value of timber.

Justification: If short rotation cropping is to be used for timber production, then attention must be given to improving the bending strength of juvenile wood by reducing the microfibril angle. Some improvement could be achieved through selective breeding. However, the tree forms juvenile wood with a large microfibril angle in order to provide the flexibility the sapling needs to avoid breaking in high winds. It is thus necessary to determine the extent to which microfibril angle could be reduced without catastrophic effects on the ability of young trees to survive high winds. Experimental work would need to be carried out to establish the relationship between microfibril angle and stiffness in trees with different types of wood anatomy, since there is evidence that hardwood trees with vessels have stiffer fibres with a lower microfibril angle to compensate for the flexibility of large diameter thin-walled vessels than do softwoods, which have only one type of axial element, the tracheid. This work would involve a combination of X-ray crystallographic techniques to determine microfibril angle, coupled with engineering tests of stiffness. By determining the limits of what is practicable in terms of reducing microfibril angle, guidance could be given to breeders and genetic engineers as to what targets to aim for, and prevent the kind of problems encountered by the New Zealand Forest Service as a result of their reliance on density as an indicator of quality. Molecular techniques could also be applied to identify differential gene expression between developing juvenile and mature wood fibres. Some work has already been carried out at Reading and a practical method for doing this has been developed. As far as reacrion wood is concerned, The mechanisms underlying the formation of reaction wood have been extensively investigated for the last 150 years without providing satisfactory answers to the problem of how its formation is induced and controlled. The advent of molecular techniques now offers an opportunity for the process to be better understood and controlled. As with juvenile wood, there is almost certainly a limit to the extent to

which the tree can be tampered with to reduce its production of reaction wood without detriment to its survival. However, as with juvenile wood, it should be possible to eliminate "unnecessary" reaction wood formation, leading to an increase in the amount of better quality timber produced by the tree.

European relevance and collaboration:

3.3.4 Competitive European wood materials for improved and new functionalities of wood products

Positioning: Basic

Short Description: Identification and evaluation of the interesting properties of European wood materials that can be utilised in cost-competitive manner in new functionalities demanded among the young urbanised people (first option)and aging people (second option). First, the critical functionalities should be defined. Thereafter, creating basis and links for the development of products and manufacturing technology for small and medium-scale as well as large wood industries. The studies should be related to at least engineered and further-processed solid wood products for construction, DIY consumer products and systems, and ease-to-use and easy-to-maintain products and systems. Visual, technical and physical characterisation of wood materials, and, as case studies, their evaluation and utilisation in selected end-use products. The focus shold be in planted forests of the relevant European softwood species where the effects of forest management schemes of growing wood for high quality and, to a limited extent, the effects of forest environment are included. Empirical focused sampling from stands, trees and green and dried wood. For case studies, billets, models or prototypes of selected products manufactured with the technology to be defined. Both indoor and outdoor uses of wood could be included. The first emphasis should be in wood for construction, but also the wood-for-living use would be interesting here. Condensed bechmarking and SWOT analysis against competing non-wood materials should be included.

Justification: Value-added of wood products based on the aforementioned justification to: 1) position different wood and wood products realistically in medium-term and long-term market, 2) create basis for marketing argumentation, 3) indicate/justify product development efforts, 4) develop the standardisation of wood products and improve wood sourcing for the end-uses to be defined. The results contribute positively to the customer acceptance of wood products among the specified groups of citizens, and, hopefully, to the cost-competitiveness of wood products in selected end-uses.

European relevance and collaboration: The theme is relevant for the consumer and public acceptance of wood in Europe, and, thus, contributes positively to the grounds of European wood products sector in the medium and long terms. The results can be an answer to imperoving the housing of the specified groups of citizens that grow in EU25. The theme requires various competence and its developments from the participating research groups, thus, contributing to the scientific networking and competence within Europe. The nature of the research is mainly basic research, however, with direct links to the industries ("applied basic research"). See also the justification (before). Research groups in wood science and technology, architechture, product design, wood chemistry and physicis as well as wood engineering and market/marketing research should participate in the implementation. Simultaneously, different culture zones and the representing research groups should be included. I suggest research groups from Finland (Metla, VTT/HUT, other partners), UK and Austria (BOKU) completed with experts from France and Sweden.

3.3.5 Product-specific use of pulpwood to improve pulp and paper qualities

Positioning: Applied

Short Description: The target of the research is to enable European groundwood mills to optimize the wood-chain between forest and mill. Up to now, wood pulp and paper industry is not considering in detail the influence of wood structure of the raw material on resulting pulp and paper quality or pulp recovery rate. In coniferous trees, diameter growth affects the formation of cell structure. Latewood, earlywood or reaction wood differ in their structural an chemical composition, which lead to differences in cellulose and lignin content of the wood or the fiber structure. Determining which growth rates would produce the wood with the best properties for pulp and paper production will help to reduce costs and improve pulp quality. The research issue must be conducted in an interdisciplinary approach in the areas of silviculture, forest botany and wood anatomy, genetics and forest utilization. Wood structure of species used in pulp production has to be analyzed and linked to growth conditions that can be controlled by forest management. On the other hand, anatomy and chemical composition of cell and wood structure of trees growing under different conditions have to be analyzed in order to detect the effect on pulp yield and pulp quality.

Justification: Structural and natural disadvantages and specialties of pulp and paper production in Germany and Central Europe will be overcome with a quality information management system. Management of the forests, classification of the raw material as well as raw material supply may be optimized. The quality of pulp and paper can be improved while costs are reduced.

European relevance and collaboration: European pulp and paper producers compared to global players have some disadvantages in the production. The research issue that aims to optimize raw material supply will enable the industry to be more competitive on the world market. Potential research groups: Pulp and Paper Industry (Germany and Scandinavia).

3.3.6 Production and processing of sawlogs for high quality timber production

Positioning: Applied

Short Description: The research aims to analyse three factors considered as decisive for high value wood production: I) the impact of tree growth to physical and mechanical wood properties, II) what physical wood properties at cellular level are relevant to wood quality and III) how negative effects of unwished wood properties while processing can be reduced by appropriated processing technologies. The overall objective is to link tree growth and quality modelling in order to adapt and optimise growth conduction and wood processing to the special requirements of certain tree species. Since tree growth influences wood properties, the characteristics of diameter growth leads to specific cell formations. Cell structure on the other hand influences wood structure, having consequences for the behaviour of the wood during all processing steps, and the quality of the final products. Since silviculture, and genetics are affecting tree growth, an interdisciplinary approach is necessary for this research. Adapted management methods and tree breeding programs may help to improve quality of the roundwood. For further processing, detailed information about wood anatomy has to be provided. Laboratory tests of samples and specimen have to be conducted by specialists in the area of wood utilization to determine physical and mechanical wood properties.

Justification: The results will help to improve silvicultural management systems and to adapt processing methods. The outcomes make it possible to integrate the entire wood chain from the primary forest production to the end user. The data form the basis for new decision supporting tools for silvicultural management and wood processing industry, considering economical and multifunctional needs of the whole production process. With advances in new silvicultural management systems and innovative techniques in the processing plants, worldwide market chances and competitiveness of European forestry and wood processing industry will be higher.

European relevance and collaboration: The European forestry sector and wood processing industry as well as the industry providing processing technologies have long traditions and a high technical level. Due to the globalization of the markets and the socio-economic conditions found in Europe, efforts have to be made to maintain the European forest-wood-chain and processing technology at a high and competitive standard. If existing know-how is bundled in an interdisciplinary approach, Europe may be able to take and maintain leading role in research, the production of high value added wood products and the production of wood processing technology. Potential research groups: University of Freiburg (Germany), INRA (France), CIS-Madera and AIDIMA (Spain), University of Göttingen (Germany), wood industry, industry providing wood processing technology (Germany, Scandinavia.

3.3.7 Effects of Silvicultural Management on Wood Properties

Positioning: Applied

Short Description: Due to economic and ecologic reasons, since 20-30 years the goals of silviculture in Germany have been moving away from homogeneous pure stands with high volume production towards uneven-aged, naturally regenerating mixed stands with comparatively low stand densities, in order to increase value production and ecological stability and to reduce the costs for planting and tending. However, since low stand densities inevitably induce broader tree rings and thicker branches, debates are still going on about the wood properties and the timber quality of trees coming out from such managed stands, especially since the development towards even lower stem numbers still continues. To investigate the effects of silvicultural management on wood properties (knottiness, ring widths, wood density, reaction wood, resin pockets, red heart formation, MOE, tensile-, bending- & compression strength, red heart etc.) of coniferous respectively broadleaved tree species and the resulting timber is a main focus in the research of the institute. This work is based on dendrometrical and wood technological analyses of trees and timber coming from differently managed stands.

Justification: The results gained from this research are relevant for silviculture and wood utilisation as well: Silviculture: based on the findings for timber properties, the limits of low density management strategies and single stem harvesting can be shown. As a feed-back, silvicultural models may be optimized in order to meet the goals given by the demand of a cost-efficient stand management on one hand and the needs to produce valuable timber on the other. Wood utilisation: the knowledge of the effects of silviculture on wood properties enables to pre-stratify the harvested round wood volume coming from differently managed stands according to its anticipated quality and the specific needs of the timber vendees. Forest owners and wood-processing industries will likewise profit from a better utilisation of the forest resources.

European relevance and collaboration: The aspects mentioned above are relevant for forestry of many central and north European countries, being exposed to comparable economic impacts and ecological demands. Therefore the research performed in this field will be of general interest for these countries as well. European research groups besides forest faculties being possibly interested in this work are for example INRA/ENGREF (France), FVA Baden-Württemberg, LWF Bayern, FVA Trippstadt (Germany), WSL Birmensdorf (Switzerland), Boku Wien (Austria), EFI Joensuu (Finnland), DFLRI Hoersholm (Denmark).

3.3.8 Effects of forest treatment on wood properties in Norway spruce stands

Positioning:

Short Description: The background of this project is the interest in many countries to change some of the silviculture from even-aged to uneven-aged treatment. To day we know much about the relation between wood properties from even-aged stands, but little about wood properties from uneven-aged stands. This can be studied by analysing wood samples from trees in uneven-aged forest treated with selective cutting and compare with samples from even-aged forest. The project presupposes long-term field experiments with periodical measurements are established several years ago to obtain wood samples. Some trees have to be cut from each of comparative uneven- and even-aged Norway spruce plots. Different parts and ages of the wood samples have to be analysed and then compared with stand development, tree growth and forest treatments.

Justification: The project will produce information and know-how about the relation between forest treatments and wood properties. These results are very important to day since changed silviculture have been discussed for several years. The consequences of a new silviculture are also important for the forest economy, to maintain biodiversity and several socio-economic impacts.

European relevance and collaboration: This issue is suitable to collaborate for European researchers since we have just a few long-term experiments in uneven-aged Norway spruce forest treated with selective cutting in some European countries. The analyses should be a corporation between wood science researchers and forest production researchers. Probably the Nordic Forest Research Cooperation Committee (SNS) with the two groups Forest Production and Wood Science in corporation with some countries from Central Europe can have a key role of this research.

3.3.9 Role of secodary metabolites in wood properties

Positioning: Basic

Short Description: Secondary metabolites in the heartwood play a key role in many important wood properties: sensorial properties, bioresistance, hygroscopic stability, viscoelastic behaviour. Combined approach between chemistry of natural substances and wood properties variations will help to find family of molecules responsible of different wood properties. This can be done using the huge diversity of woods from French Guiana forest.

Justification: Characterization of wood pieces for their high value properties and use of woods without chemical treatments. Source of new chemicals for wood treatment by biomimetic approach. Better use of the diversity of european tropical forest.

European relevance and collaboration: European industies are using commonly tropical woods for specific uses and there is a common interest to give value added to tropical forest products in a sustainable management. There is a huge diverity and thus work to be done together.

3.3.10 Effect of global changes on the production of wood

Positioning: Applied

Short Description: To use scaling methods on wood anatomy and massive non-destructive testing to undertand, model and predict the effect of climatic conditions of the future properties of wood.

Justification: Climatic conditions change at a rate which becomes very fast regarding the time constant of forests. Predictive tools are absolutly required and can be based only if the models are knowledge-based.

European relevance and collaboration: A network has to be imagined, based on a mixture of people from forestry, ecosystems and wood science. Emphasise has to be put on predictive approaches rather thna on purely statistical approaches.

3.3.11 Formation of reaction woods

Positioning: Basic

Short Description: Trees manage to control the shape of their stems through the generation of growth stresses accompanying wood formation. In the case of high demand of orientation control, they produce the so-called reaction wood (RW), defined by IAWA as “wood with distinctive anatomical and physical characteristics, formed typically in parts of leaning or crooked stems and in branches, that tends to restore the original position of the branch or stem when it has been disturbed; also known as tension wood (in deciduous trees) and compression wood (in conifer)”. This definition combines a functional and a structural aspect of RW. The research in this subject is multi-disciplinary since it involves a number of complementary scientific areas and domains of applications in a multi-scale approach: 1. tree genetics: gene expression in RW (genomic) and relation to phylogeny (evolution) 2. tree botany: i. anatomical and ultrastuctural features of RW and opposite wood, ii. relation to the architectural development of the tree, iii. relation with occurrence along the stem and position 3. tree physiology and ecology: i. induction of RW and formation process in relation to environmental conditions and tree growth processes, ii. resource allocation and energetic cost of RW production, iii. signalling and regulation aspects 4. tree biomechanics: i. functional meaning of RW, ii. relation between RW formation and tree architecture and stem geometry, iii. growth stresses prediction

Justification: Concerning points developed in the short description we can expect advances in: 1. tree breeding and genetically modified wood 2. shape control for sylvicultural and horticultural purpose, risk assessments for urban trees (falling or breakage) 3. control of RW at tree, stand and landscape level, improvement of silvicultural practices, quality assessment of the standing tree 4. stem resistance to wind and other external stimuli, growth modelling

European relevance and collaboration: This subject is partly included in the scope of the starting Cost Action E50 « Cell-wall macromolecules and reaction wood », trans-sectorial within FFP sector, which could provide the basis for a network of cooperation.

3.3.12 Properties and consequences of reaction woods

Positioning: Applied

Short Description: Trees are able to restore verticality by producing on one face reaction wood (RW) with a different stress level compare to the other face of the stem. RW is characterised not only by its stress level but also by large changes in the ultra structure and chemical composition which induce change in the wood behaviour. RW is then generally considered as a defect for wood product. The aim of the project is to increase the knowledge of properties of these atypical woods in order to face the technological problem. 1. RW properties: i. links between structural, chemical, physical and mechanical features of RW and RW fibres, ii. typology of RW (micro and macro scales), iii. estimation of the amount of various RW-types, (i.e. mild, strong, severe RW) in the wood raw material, iv. relating wood behaviour to wood formation, v. micro-macro modelling 2. wood and paper technology: i. modelling growth stress release in products, ii. mapping RW at processing stage and in products, iii. relating RW and technological properties.

Justification: Concerning points developed in the short description we can expect progress in: 1. RW detection, database of RW properties, potential use of RW (biomimetic) 2. managing growth-stress related problems during the early transformation process (log-end cracks, lumber deformation during sawing…) 3. managing heterogeneity related problems (deformation of lumber during drying and of end-products during usage)

European relevance and collaboration: Various EC project have addressed reaction wood related problems : compression wood (QLRT-2000-00177 project “Compression wood in conifers - the characterisation of its formation and its relevance to timber quality”(FP5)), tension wood in Beech (FAIR Project CT-98 3606 “Stresses in beech”(FP5)). They highligted the need for research at the european level. The development of fast-growing plantations in Europe and others part of the world results in more production of lower-quality wood : higher proportion of juvenile wood but also of reaction wood due to unstable growth. The former projects + the starting Cost action E50 can produce a useful network for a collaboration.

3.3.13 Effect of process variables on surface properties of wood material

Positioning: Applied

Short Description: The aim of the study is to determine the most important phenomena which have effect on surface properties of wood. The combined effects of industrial production processes and material characteristics to the surface properties of wood will be studied. The idea is to concentrate on studying the effect of surface properties of wood on adhesion and gluing process. In order to be able to have a breakthrough in the area of adhesive bonding of wood the whole industrial treatment process with all its parameters and their interaction with surface properties of wood should be studied. Also the possibility to measure certain crucial properties on-line during the industrial process will be studied. With integration of the previous results and novel research with modern techniques it is possible to achieve more uniform theory of the phenomena. Co-operation with both industry and leading European research institutes is needed. The main methods to study surface properties will be contact angle, pH, CLSM, FTIR, ESEM and Raman spectroscopy. These methods enable to describe both chemical and physical properties of wooden surface. Most of the equipment needed is located in Helsinki University of Technology (HUT) at the Department of Forest Products Technology.

Justification: In the future one of the key research issues will be adhesive bonding of wood and adhesive properties of wood, because there is an increasing demand for efficient use of wood raw material. With the help of the methods that will be employed in this study it will be possible to obtain more detailed and precise information about wood surface properties and their impact on bonding quality and thereby provide solutions to the adhesion problems. The results of this study can be directly implemented in wood product industry, because research will provide knowledge about the interaction of different process variables on wood surface properties, which can be utilized to optimize the treatment process. The process optimization will result in reduced expenses and improved quality. Negative environmental effects will be reduced, because it will be possible to regulate the usage of natural resources more precisely and reduce waste generation. This is not possible without careful research and thorough understanding of the treatment process and its effect on surface properties of wood.

European relevance and collaboration: On the European level it has already been admitted that problematic issues concerning surface properties of wood and wood as an adherend should be studied more thoroughly. Therefore several COST actions (E34 and E35) have been formed, where the leading European research institutions and scientists co-operate in these areas. Present research will be useful for the wood research laboratories in order to comprehend the importance of wood surface properties and resolve the adhesion problems. Remarkable progress in research with relation to this area has been done in Max Planck Institute at Potsdam, Swiss Federal Research Institute (EMPA), University of Helsinki, University of Natural Resources and Applied Life Sciences (BOKU) in Vienna, Trees and Timber Institute (IVALSA) in Italy and in

University of Reading. Co-operation and exchange of knowledge with these institutes and other participants of COST actions E34 and E35 is essential for this project.

3.3.14 Formation of wood properties in the growth process

Positioning: Basic

Short Description: In order to understand how climate and forest management affect wood quality, we need to analyse the growth process which on one hand is affected by the environmental drivers, and on the other hand, results in the formation of wood properties, including knots and stem form as well as wood density, fibre properties, etc. The theme would integrate existing physiological and eco-physiological knowledge with raw material properties and requirements, as well as increase our knowledge base and understanding. The theme would link expertise on whole-tree physiology and wood material science. It could also benefit from biochemical understanding of the genetic aspects of wood formation. In addition, mathematical, modelling, and computing skills would be required.

Justification: This kind of integrated understanding is essential if we intend to develop the forestry value chain towards a knowldege-based technology. It provides the key link between silvicultural measures and industrial use of wood as raw material. It also helps understand the impacts of climate change on forest growth and wood quality.

European relevance and collaboration: The general methodology required in this research theme is independent of country or tree species. There is expertise in many European countries on these things (e.g. round a IUFRO working party on the links between growth, silviculture and wood quality, lead by Gerard Nepveu, INRA, France). Relevant groups can be found at least in Finland, Sweden, France, Portugal, and Germany.

3.3.15 Climate and wood

Positioning: Basic

Short Description: The efefct of climate change (elevated CO2 and O3, increasing temperature) on tree growth and wood properties is not fully understood. More analyses of long term field experiments and especially provenance experiments are needed to clarify the efefct on future raw material.

Justification: The impact of climate change can be taken into account in future forest regenaration and management. Better targetting of raw material. It is a key issue for the environment and society.

European relevance and collaboration: Climate change is a European-scale problem and an european co-operation in utlisation of different field experiments and results is urgely needed. Many european laboratories work in the field.

3.3.16 Measuring and modelling deformation in wood with high microfibril angle

Positioning: Basic

Short Description: It seems clear that experiments on wood with high microfibril angle, such as conifer compression wood, are needed to understand the mechanical properties of wood in general. Models susch as the 'stick-slip' model and our variants on it need to be explored by distinguishing reversible from irreversible deformation (macro-level)and identifying polymer displacements under load (nano-level).

Justification: 1. Better models of load-deformation behaviour of softwoods and influence of MFA 2. Better understanding of negative properties of CW 3. Improved processes for hydrothermal forming of wood

European relevance and collaboration: Clear world lead for the European groups if they can work together MPI-Golm, STFI, Glasgow, Manchester - also Lausanne (CH).

3.3.17 Factors Controlling Wood Formation

Positioning: Basic

Short Description: The exact details of how cell structure is affected during cambial initiation and then secondary thickening by environmental and genetic factors is extremely important. Although we know much about how these factors control cell formation there is much to learn and particularly in relation to the properties of importane for wood and fibre performance (microfibril angle, cell wall thickness, chemical composition, etc.)

Justification: A thorough understanding of the factors controlling cell formation and structure will allow more sophisticated process-based models to be developed. Such models will help to determine the impact of climate change, mangement, genetic improvement, etc. on the wood properties of the future forest resource. Such knowledge can help plan at a European level the types of industrial investment required.

European relevance and collaboration: The tools and techniques for answering these fundamental questions range across many laboratories in Europe. Some of the techniques are very specialised and only available in individual laboratories. Collaborating will allow more techniques to be applied to answering these problems than if the work is purely carried out at a national level. It will also allow teams to be developed with the range of skills required to tackle these basic questions.

3.3.18 Bulk up knowledge at micro level to macro level (sawn timber)

Positioning: Applied

Short Description: A lot of efforts have been led across Europe on studying factors which affect timber properties. Often these properties have been mapped inside tree stems from pith to bark and from butt to top. The arrival of the Silviscan system in Sweden has just made such analyses much faster and more detailed so that the years to come will probably provide even more information on the micro properties of wood. Meanwhile, it remains that the factors which affect the behaviour of sawn battens (macro level) are often not well understood. For example, while the microfibril angle of the cells can be predicted for many European species as functions of factors such as site quality, management regime, cambial age and position in the ring, predictions of twist and distortion (which are largely dictated by the microfibril angle) in battens can often not be made. It would be desirable to initiate a research programme focusing on the rationalization of micro-level knowledge into practical macro-level applications, particularly in the field of wood dimensional stability. Existing models which map micro-level wood properties in the stem could be extended to make predictions at the macro level.

Justification: Being able to link forest management factors to the performance of the final product would represent a crucial innovation for several European species. The competitiveness of the whole forestry woodchain could be dramatically improved if foresters could predict the effects of their management choices on future product performance. Of course, a precondition for the success of such a project would be that partners already hold some reliable data on properties at the micro-level.

European relevance and collaboration: Several European countries grow the same forest species but have tended to focus their efforts only on their major species. By working together on such a project, our overall knowledge of the European timber resource could rapidly grow. Two types of partners should be involved in such a project: 1. those which hold models capable of predicting micro-level wood properties as a function of site and management. 2. those which have expertise in performance of timber at the macro level. Examples are: Forest Research (UK), Building Research Establishment (UK), Chalmers University (Sweden), INRA (France), Norwegian Forest Research Institute (Norway), Forest Research Institute Baden-Württemberg, (Germany), STFI-Packforsk (Sweden).

3.3.19 Predicting Product Quality Through Environment and Silviculture

Positioning: Basic

Short Description: The research is primarily about the environmental conditions relating to formation of wood and fibres of different characteristics. I think it is necessary to be able to understand the quality of product produced under a given set of environmental and silvicultural conditions. Something is known, though not fully understood about the effects of various silvicultural practices on timber quality and there is knowledge about which environmental processes cause plant growth. However little is known about the effect of environmental conditions on wood formation and characteristics (cell wall thickness, cell dimensions, fibre length, mfa, compression wood). I am therefore in favour of quantifying the effect of environment on wood and fibre characteristics under a set of 'real world' conditions and adding this element to existing empirically driven silviculture models on timber and fibre properties.

Justification: From this research it should be possible to predict wood and fibre quality from a combined model for silviculture and environment, therefore being more accurate than a model that predicts by either alone. This could define a suitable for use product before harvest and informed decisions on planting. It would almost certainly benefit all parts of the wood industry to be able to know that under a certain set of conditions which kind of wood and fibre properties were likely to occur.

European relevance and collaboration: This issue affects all involved in the wood industry in all countries. Without collaboration this research would not be possible as it requires speciality in different areas: Timber, Fibre (Pulp) and Forests. Indeed much of the knowledge on how various processes affect wood and fibre characteristics exists but it is not well brought together on a Europe wide scale. Groups that could be included are Forest Research, INRA, STFI, AFOCEL, Freiburg University and SLU. All of whom already have a good base for modelling fibre and wood characteristics and knowledge of established techniques with which to measure these.

3.3.20 Molecular control of wood development

Positioning: Basic

Short Description: Wood formation is a developmental process involving cell proliferation, cell expansion, cell differentiation (with pronounced deposition of cell wall polymers cellulose and lignin) and cell death. Although some information on genes active during this process have been recently reported through genome wide gene expression profiling experiments, we still lack much of the basic functional understanding: how do these genes operate together to make wood? In addition to tree system, Arabidopsis thaliana is an efficient model to answer these questions.

Justification: Through knowledge on gene functions during wood development, it should be possible to affect the raw material properties of wood in a desired manner.

European relevance and collaboration: Europe is very competitive in this area. Especially research groups in Belgium, Finland, France, Sweden and U.K.

3.3.21 Databases and models for variation in wood and fibre properties

Positioning: Applied

Short Description: The objective is to describe how major sources of variability affect important wood and fibre properties for a number of wood species in some European regions. Common practices are applied in the collection of samples and analysis of properties. Databases with common structures are built with related information on properties of stands, trees wood and fibres. From these data, models are developed describing the differences in properties and effects of various factors in the same model format, regardless of the factor behind. These models will create a basis for a large variety of applications. Everything can not be covered, but the study should include some wood species and for each species differences between say 2 regions (latitude, climate, ...), within regions (altitude, …), between stands (fertility, silvicultural practises …), between trees of different competitiveness and between parts of trees. The key factor to the investigation of how various factors are affecting wood and fibre properties is access to efficient methods for characterization of the relevant properties. Other important factors are good strategies for sampling, preparation of samples, building of databases, illustration and evaluation of variability and modelling with different levels of detail and simulation of interesting cases and scenarios.

Justification: The project would result in data on and models for differences in wood and fibre properties and how these are affected by various factors and how they may be controlled by different actions. This would be important knowledge. It would also be a good basis for the development of a large number of applications in forestry as well as at the industry. Examples are the inclusion of property information in forest inventory data, new tools for planning in silviculture and harvesting, on line estimation of properties in logs during harvesting and more optimal allocation of wood and fibres to different industries and products, to the benefit of both industry and forest owners. Among the factors investigated should be effects of new regimes such as continuous cover forestry and other measures taken in consideration to environment and social impact. This would provide important tools to foresee what new conditions such changes may bring to forest owners, industry and society in the future.

European relevance and collaboration: The usefulness of the approaches outlined has been shown in several projects on various wood species in different countries. The Wood and Fibre Measurement Centre at STFI-Packforsk has been a core resource, complemented with contributions also by a large number of partners engaged in different projects. Examples of partners in Europe are Skogforsk, AFOCEL, Forest Research Scotland, PFI, Metla, University of Helsinki and a number of companies. In the research suggested, research groups with special knowledge about the wood species, the factors and the regions involved should be engaged.

3.3.22 Wood fibre nanostructure; a basis for improving fibre processes and final products

Positioning: Basic

Short Description: An understanding of the fundamental nanostructure (i.e. ultrastructure) of wood and pulp fibres is an important basis for the optimal use of fibres in most products (e.g. biocomposites, paper etc) and processes (chemical, mechanical, biological) –current and future. Currently this knowledge remains incomplete and a stumbling block for the optimal development of new products and processes based on green materials. Fundamental issues of the ultrastructure of wood and fibre materials include: - Fundamental understanding of fibre ultrastructure in native wood; - Ultrastructural modification of fibres via enzymatic and chemical processes; - Improved processing of chemical pulp fibres through knowledge of fibre ultrastructure; - Ultrastructural aspects of mechanical pulp fibres with a view for saving energy resources; - Understanding fibre modification for uses in current and future biocomposites; - Understanding ultrastructural changes in gene modified fibres; - Development of nanoprobes for following changes in fibres during processes.

Justification: Strengthening European competitiveness and applications of fibres. More efficient and wider use of wood fibres; better understanding of fibre structure leading to energy savings in pulp processes and more selective use of chemicals and thus environmental gains. The improved understanding of fibre ultrastructure can have a great impact on current uses of wood and fibres in current and future products.

European relevance and collaboration: Wood fibre ultrastructure represents an important part of several EU-COST actions –past and present- (e.g. EU20, EU35, EU50). Research groups from these countries (especially Sweden, Finland, France, Germany) involved in these COST actions as well as industrial sponsors are all potential partners in a collaborative research European project. The techniques employed are equally important for applied and fundamental research over the entire spectrum of studies involving wood and fibres.

Sub-area 3.4 Silvicultural methods, procurement and harvesting operations

3.4.1 allocation of wood resources.

Positioning: Applied

Short Description: The objective is to develop automated, energy efficient and environmentally friendly technology for the detection of desired wood origin and its properties. Development of technology for the detection of wood origin and its desired properties by use of advanced Information Communication Technology systems – such as radio frequency identification, global positioning systems and remote sensing information - establishing a digital chain of information for planning, execution and business control within the forest –wood chain.

Justification: Technology will be further developed which will provide a better processing flow and therefore will reduce costs and environmental implications. this will enhance the industrial competitiveness not only due to a better market orientation and capacity use but also due to a better control of resource management and enhanced tracing of logging and wood transport.

European relevance and collaboration: The European community will strengthen the information technology use and establish under the GMES and GEO programme new monitoring and database structure which allow access to more homogeneous and standardized data.

3.4.2 Advanced use of information and communication technologies in the management of natural resources.

Positioning: Applied

Short Description: The objective is to integrate advanced IT technologies in the forestry sector resulting in improved tools for forest management in the whole forestry-wood chain.

Justification: Providing innovative, cost-effective, sustainable and user-friendly data mining, data exchange, modelling, mapping and and visualisation services for decision-makers enabling improved management of forest resources and the whole forestry-wood chain. Research should focus on combining and processing large quantities of existing data and information from diverse and often unrelated sources in order to increase competitiveness for example by allocation of raw material to the end-users in an optimal way, to prepare logging concepts to support silvicultural managment decisions.

European relevance and collaboration: Within the European Union the use of IT technology to enhance business structures, support political decisions and improve sustainable development under environmental, social and economical aspects has high priority. environment

3.4.3 Risk management

Positioning: Applied

Short Description: An anticipatory management of risks will also be of increased significance for forest management. Improved use of new spatial technologies like remote sensing technologies, GIS technologies, spatial modelling and spatial visualisation technologies will help to identify risks and develop preventory measures damge action plans. The objective is to test and develop improved remote sensing and geodata based models for obtaining precise information on risk factors and risk situations for forests on different scales. Research will focus on improved integration of services based on space data in the forest sector, especially in an integrated way with existing monitoring and mapping processes;

Justification: The use of space data is still not efficiently integrated in monitoring, mapping and modelling for spatial information. This is true even so in the last year improved space data products are on the market which provide information not or only very costly or difficult accessible based on terrestrial assessments. Intelligent combinations of spaced based information and terrestrial information is needed to be efficient. This involves also the integration of existing data bases in map production and modelling processes.

European relevance and collaboration: The European and global interactions in risk assessment and prevention need to use new information technologies. In addition a more efficient use of resources is of high relevance for European competition.

3.4.4 Soil sensitivity adapted timber production

Positioning: Applied

Short Description: The research intends to analyse, how timber industry oriented silvicultural strategies influence soil functions with special consideration to EU soil protection policy. A stronger adaptation of silvicultural strategies on timber market and industry needs may provoke the following scenarios (i) shortening of the rotation period due to an increasing demand of smaller dimensions, (ii) a strict orientation of the tree species choice towards fast growing conifers and (iii) a return from multilayered stand structures to homogenous stands. These three scenarios lead (a) to an intensification of nutrient removal through a higher frequency of harvesting operations, (b) can disturb the soil ecosystem balance and (c) consequently reduce soil productivity in the long run. The issue demands a comparative analysis of plots standing for the three scenarios with near-to-nature stands in representative forest systems along a gradient of varying soil sensitivity. The influence on chemical and physical soil properties, mycorrhiza and soil fauna and flora as well as tree growth will be assessed and help to develop soil sensitive production strategies. As information basis, EUSIS, National Forest Inventory, monitoring plots (Forest Focus) as well as industrial production goals and actual silvicultural strategies will be used to identify appropriate test regions and sites.

Justification: The research issue intends to bridge the gap between industrial production goals and the natural production basis. As result, a decision basis (e.g. thematic map / information system) is expected, resuming information to which extend different industrial production goals can be realized in a still soil function sustaining and soil framework directive conform way. The innovation potential consists in a knowledge-based soil-sensitivity-adapted forest management intensity differentiation. This ensures long-term sustainable supply of industrial raw material and helps to mitigate at the same time unfavourable impact due to an intensification of soil use. The economic and environmental impact consists in a segregation into production and protection dedicated areas, which can provoke a regional shifting of profit opportunities in favour of an improved soil management at large. This stresses the need for an accompanying socio-economic impact analysis.

European relevance and collaboration: On European level, certification standards often follow a regionally differentiated perception of the sustainable use of forest soils. A generalizeable classification of soils according to their sensitivity delivers a comparable basis for the estimation of the impact of stronger industry oriented silvicultural strategies and reveals regional and trans-regional potentials and limits. This is a valuable instrument for an inter-European coordination and optimization of production goals concerning better sustainable management of forest soil functions and forest soil productivity. A key role can be played by the ENFORS working group, the European Soil Bureau Working Group and stakeholder associations (e.g. Confederation of European Woodworking Industries, European Timber Trade Association).

3.4.5 Sustainable institutions for a competitive forestry for small private forest owners.

Positioning: Applied

Short Description: Conditions on the European timber markets are changing quickly. Globalisation takes place, technology changes. The processing industry grows in scale and scope and structural characteristics of forest owners shift. Those changes require institutions to be adapted. The mode of governance, formal and informal rules, contracts, organisations need to be changed, for remaining competitive. Particularly small scale private forest owners face a severe collective action problem. In Europe, there is currently a huge testing of institutional arrangements under way. Many Middle and Eastern European countries have lived through substantial restitution processes in the forestry sector, which made a reorganisation a necessity. Often the restructuring process has not yet finished. In various Western European countries the state wants to step back from its dominating role, and particularly small scale private forests lack competitiveness. Other countries instead have been successful in creating or maintaining a competitive small scale private forest. For studying those various processes a comparative case study approach is suitable. A range of countries belonging to the different groups, mentioned above, should be selected. Within those countries, the legal institutional preconditions should be analysed and various successful and unsuccessful cases within those countries of achieving sustainable competitiveness should be compared.

Justification: As mentioned above small scale private forest owners face a collective action problem. Therefore, we might not expect that private initiative on its own solves the problem of competitiveness of the sector. However, the initiative must be one of the concerned actors. The research wants to provide the sector with the necessary knowledge for this process of change. The aim of the research would be to show and propose various institutional innovations, which enhance competitiveness of the sector itself and therefore lead to a better integration into the wood supply chain. The proposed research would help industrial competitiveness in two ways. First it would help the competitiveness of forestry itself. But second, maybe more important, it would help the long term competitiveness and sustainability of the timber processing industry. Some saw mills already face supply problems. However, once unsustainably used forests outside Europe are used up, the sustainability and competitiveness of the resource base will be crucial for the industry. Currently, Western European forests are used sustainable. Institutional changes should preserve and secure this sustainability, which is a precondition for long term competitiveness. This will have a stabilising and positive effect on rural development.

European relevance and collaboration: The issue is particular suitable for pan-European research, because we can see a significant heterogeneity in the potential and success of the competitiveness of small scale private forestry in various countries in Europe. This heterogeneity seems to be mainly influenced by institutional differences between the countries, not only formal institutional differences – how they are codified in

national laws, but also differences in informal or de-central institutions, for example, on a contract level. It would be important to explore these differences and their consequences on competitiveness. This heterogeneity is coupled with a truly European timber market and wood processing industry. This combination of homogeneous requirements and heterogeneous abilities makes a European comparison particularly revealing. The research topic could be developed out of the group of researchers associated in the COST action E51 "Integrating Innovation and Development Policies for the Forest Sector". There is a small but growing number of researchers within the forestry sector, which have dealt with institutional development. However, it might need to be necessary to complement this with researchers, coming from an institutional economics background.

3.4.6 Comparing contracting systems socio-economically

Positioning: Applied

Short Description: Looking at the history of forestry contracting systems in Europe, one can see quite different developments in the Nordic Countries, in Western Europe, Central Europe and Eastern Europe. The out-sourcing of forestry work and the introduc-tion of highly mechanized forestry developed in different ways and with a differ-ing time-scale. Identifying key factors for these diverging development paths and researching the socio-economical consequences of the various contracting systems helps to find out more about the advantages and disadvantages of the different systems and to enable a justified forestry policy proposals for the further devel-opment of harvesting and contracting systems. Methodically, countries with dif-ferent contracting systems will be compared, reconstructing the technical and socio-economical trajectories leading to the current system, and looking at devel-opment potentials, preconditions and possible future transformations. The results will be compared with the work of the Canadian scholars M. Clow and P. Mac-Donald about the establishment of harvesting and contracting systems in eastern Canada and the southern states of the USA.

Justification: Forestry and the maintenance of harvesting operations increasingly depend on out-sourced work of forestry contractors. To establish a sustainable production of raw materials for wood processing, the social, economical and environmental ef-fects of different harvesting and contracting systems should be of high interest. The outlined research could in comparing different contracting systems help to decide about their relative sustainability and their further development. In that way, the outcome of the research could help to development a competitive, yet wholly sustainable policy for operating forestry in Europe.

European relevance and collaboration: As described above, the outlined research could increase the sustainability and at the same time the competitiveness of forestry in Europe. For a comparison of con-tracting systems, it is important to look at contrasting cases and their specific his-tory. This is only possible in a European context and with collaborative work be-tween different institutions and research groups in the fields of forestry work sci-ence, forestry technology, science and technology studies, industrial and rural sociology. Existing arenas of co-operation between forestry work science and for-estry technology institutes in Europe – like the yearly FORMEC conference – could be helpful for establishing the research network necessary for the kind of research described above.

3.4.7 Effects of mechanised harvesting on economy, silviculture, stand and soil

Positioning: Applied

Short Description: Mechanisation in forestry aims at improving the performance of machines used in logging and skidding operations in any given terrain and stand in order to increase the yield on one hand and to minimise soil and stand damages on the other. The research of the institute in this field is focused on the following aspects: • Silvicultural strategies lead to uneven-aged mixed stands with large-sized wood. Case studies of mechanised harvesting systems have been made concerning productivity, technical restrictions and damages to the residual stand. The results show the chances and restrictions of mechanisation. • Managing forests in steep slopes is a major problem to forestry in mountainous regions, since the costs are enormous. Mechanised harvesting systems may help to increase the net outcome also under such situations. Research issues are the productivity, costs, and the impact on stand and soil. Study methods are case studies and surveys. • For modern forestry, mechanised harvesting techniques are inevitable. On the other hand, harvesting machines may cause serious soil and stand damages. Research of soil and stand preservation is focused on developing permanent skidding trail systems by identifying, evaluating and possibly integrating old crossed trails.

Justification: The research is important for forest practise and machine manufacturers as well. Wood is a renewable raw material. For its utilization harvesting operations are necessary. With regard to a multi-use-forestry, the utilization is competing with recreation and protection functions. Harvesting operations hit economical, social and ecological aspects at the same time. Therefore studies of the impact of harvesting operations are necessary, where the collaboration with other disciplines like e.g. soil science, silviculture, and mechanical engineering.

European relevance and collaboration: The problem of rationalized and low impact harvesting operations is concerning all European countries. Studies at European level will generally applicable decision tools. There are European groups who have collaborated on different topics, e.g. silviculture and harvesting operations (CONFOREST-EFI), harvesting operations on storm damaged areas (STODAFOR), harvesting operations and soil preserving. Potential study partners are the universities, forest research institutes, machine producers, forest administration and forest companies of all European countries. For this reason only a collaboration of researchers and users will lead to success.

3.4.8 Reduced impact logging in sensitive forest ecosystems

Positioning: Applied

Short Description: Sensitive forest ecosystems can be heavily disturbed or even destroyed by inadequate management and harvesting operations. Beside this, more damages on the remaining stand as well as a higher quantity of wood residues is produced at all steps of the operating levels. In order to optimise management and harvesting operations the impact of different management intensities on the ecosystem has to be carefully analysed. All steps beginning from pre-harvest inventory, soil compaction, harvest and skidding damages and later on a post-harvest assessment have to be implemented. The knowledge and technologies applied in Europe should be transferred to sub-developed countries and be adapted to the ecological, social and economical conditions found in this regions.

Justification: The European Commission made the commitment to assist and promote technologies and technology transfer that helps to reduce worldwide deforestation, especially in the tropics. The results will provide tools to avoid or to reduce negative impact of forest utilization in sensitive forest ecosystems, at the same time offering the possibility of increasing income for local rural population in poor countries. Sustainable forest management is one of the pre-conditions to maintain these ecosystems.

European relevance and collaboration: The high level of knowledge about Reduced Impact logging systems in Europe can be transferred and adapted to third world countries, especially in the tropics. This may help to fulfil the aimed development activities of the European Commission and to reach the reduction of forest degradation and destruction at a global level. Potential research groups: University of Freiburg (Germany), CIRAD (France), University of Wageningen (NL), Counterparts in overseas (Africa, Asia, Latin America), University of Göttingen (Germany).

3.4.9 Risk assessment and risk modeling for European forest ecosystems under changing environmental conditions

Positioning: Applied

Short Description: European forest ecosystems are subject to an increasing pressure of biotic and abiotic damaging agents. For a long term sustainable management of these forests with respect to all forest functions it is of crucial importance to have an idea of how susceptibility of the forest ecosystems towards the major risks (storm, snow, insects, fire, pollution, …) develops under changing environmental conditions. - Comprehensive risk assessment for the major abiotic and biotic damaging agents (wind, snow, insects, fire, drought, fungi, human impacts, …) to European forests- Scenario analysis of the future development of the framework conditions for the growth of European forests (climatic conditions, human impact, …)- Development of a comprehensive unified methodological framework for a risk model for European forest ecosystems (including statistical as well as mechanistic models and artificial intelligence)- Modeling of the probability, the magnitude and the periodicity of the main damaging agents based on the generic model- Assessment of the influence of different management strategies on risk under different environmental scenarios- Development of optimized management strategies to minimize risk -

Justification: Development of a comprehensive decision support system to manage European forest ecosystems under changing environmental conditions in order to minimize risk and to fulfill society's needs. The industry essentially relies on a sustainable delivery of the resource. This is highly influenced by risk. A scenario analysis of the availability of the raw material under the influence of risk is of crucial importance for investment planning and management of the timber industry.

European relevance and collaboration: The research aims at enhancing sustainable resource management which is the central goal of the Helsinki. process. Managing and mitigating risks is a core precondition of the Helsinki criteria of sustainable forest management. NFRI (National forest research institutes in Europe); European Forest Research Institute (EFI), members of EFORWOOD.

3.4.10 Effect of tree harvesting techniques on physical and environmental processes and functions

Positioning: Applied

Short Description: The determination of mechanical properties of forest soils as affected by forest harvesting techniques will be determined by stress strain and stress dependent changes soil physical properties like air and water permeability and their anisotropy with depth. The mechanical processes during tree harvesting procedures will be registered in order to lateron also use those data for a FEM analysis, which finally can be used for site specific scenario discussions about the consequences for the environment

Justification: Soils as non renewable systems are intensely affected by a non site specific mechancial stress application and result in an irreversible soil degradation which also affects various components of the environment. The insitu analysis of stress strain processes during harvesting (and planting) operations and the additional determination of changes in physical, chemical and biological site properties can be not only the basis for the defvinition of a site specific soil strength (through the paprameter Precompression stress) but it is also the basis for the definition of site specific acceptable machenery (e.g. harvesters) which also allows for various mapping scales the regional description of acceptable forest technologies. It has an enormous impact not only for the forestry maqnagement but also for the financial survey and maintenance costs and can also be used as the basis for environmental budgeting of human impacts.

European relevance and collaboration: The euriopean wide increasing forest soil deformation through harvesting precesses may result not only in an a further complete soil degradation and reduced tree growth but it has an enormous impact also gas emission (global change problems), increased surface water runoff and an increased polltiion of the environment.

3.4.11 Adequate tax system for forestry

Positioning: Applied

Short Description: Within the decision process - particularly in forest management decisions and decisions to purchase and sale forests – tax regulations are regularly relevant decision variables. In multifarious ways the rules of taxation affect forestry, e.g. real property tax or inheritance and gift tax or income tax, transaction tax like land transfer tax or value added tax as other taxes such as eco-taxes. The issues of suitable tax regulations for sustainable and multifunctional forestry are up to now not adequate scientifically analyzed. Because of the high relevance of tax regulations within the decision framework it seems to be important to establish research themes with regard to forest taxation.

Justification: The research project should contain among others the following aspects: -survey and description of the different forest taxation systems and the tax burden in different European countries, -integration of forest relevant taxation regulations in decisions models to identify optimal decisions from the viewpoint of the forest owner, -analysis of the real behavior of forest owners especially with regard to the different tax regulations, -development of adequate forest taxation systems in view of supporting sustainable forestry.

European relevance and collaboration: The forests in European countries are prevailing managed by private forest owners. Adequate and efficient institutional regulations have to give incentives for multifunctional forest management.

3.4.12 Effects of the ecological silviculture on the quality of oak- and pinewood

Positioning: Applied

Short Description: Pure Scotch pine forest stands with little structure cover large areas of the sub-continental western Polish and northeast German plains. Due to ecological and economic disadvantages of such a structure, they are to be transformed into near-natural mixed forests, the species composition of which is to resemble that of the original natural Scotch-pine-and-sessile-oak forests. Since 1990 Sessile-oaks were planted under the canopy of Scots-pine or in little gaps on about in Germany and in Poland. This trend continues. From an ecological point of view, this development is positive, but only little is known about the effects of this change in silviculture on the quality of wood of the two light-trees, sessile oak and Scotch pine, and thus on the possible economical consequences for the forest industries. The effects of ecological silviculture on the quality of wood, the range and the economic outcome could be investigated by the evaluation of existing data, monitoring, networking current research projects in both countries and the establishing of some new tests plots.

Justification: On the basis of the current research strategies and programmes of ecological silviculture in western Poland and eastern Germany insights that help economic decision-making may be obtained. The forest companies will be in a better position to estimate the effects of different silvicultural models and proceedings on the quality of the wood and the economic basics values. The research will support the competitiveness of the forest companies and deliver reliable data to the woodworking industry. The clear application use of the research can contribute to identify the economic frame of the ecological silviculture in the sub-continental area of western Poland and eastern Germany. It is an important part of a sustainable rural development in both countries.

European relevance and collaboration: Pure Scots pine stands cover large areas of central European plains artificially divided by the Poland-Germany border. There are a few research centres located in the area of interest, which have a large experience in silvicultural, economic and growth&yield related studies. Forest Research Institute in Eberswalde, Germany, Forest Research Institute in Warsaw, Poland and Faculty of Forestry at Warsaw Agricultural University, Poland, have collaborated for many years sharing information, data and results. There is also an extensive network of permanent sample plots located in western Poland and northeastern Germany, which can be used in the proposed research. Even an extensive collaboration has taken place since many years, its intensifying could benefit not only interested partners, but also could have a positive impact on forest management and economy of the entire region. Participants and research groups: Prof. Dr. Höppner / Dr. Gernod Bilke (Forest research institute, Eberswalde, Germany) Prof. Dr. Andrzej Klocek (economics), Prof. Dr. Jan Zajaczkowski (silviculture) , Dr. Stanislaw Zajac (economics) (Forest Research Institut, Warsaw, Poland) Prof. Dr. Arkadiusz Bruchwald (growth&yield, forest inventory), Prof. Dr.

Bogdan Brzeziecki (silviculture), Prof. Dr. Piotr Paschalis (wood quality), Dr. Michal Zasada (growth&yield) (Faculty of Forestry, Warsaw Agricultural University, Poland)

3.4.13 To what extent can "bioautomation" replace stand tending?

Positioning: Basic

Short Description: Traditionally, young forest stands were tended at different degrees of intensity to direct stand development with regards to species composition, stability, and tree quality. When stands are young and trees have not reached commercial dimensions, these tending activities incur only costs, which forest enterprises would like to avoid. Bioautomation, which means in this case self-thinning, has been advocated as a natural process that can replace the spacing and thinning interventions, in particular in hardwood regrowth. While it is clear that costs can be reduced by avoiding or minimizing silvicultural inputs, the future losses in reduced productivity (in particular in terms of stand quality) have not been examined, and the trade-offs are therefore not clear. In addition, the timing of first thinning may be important for the formation of the coarse root system providing the tree with anchorage, as has been indicated for some conifer species. Thus decisions about the intensity and timing or the avoidance of stand tending are currently not being made on an informed basis. To address these issues, the quality development of young hardwood stands as well as the stability of the root system in the dominant cohort need to be analysed for various thinning/spacing regimes and stand densities.

Justification: Through this study it will be possible to demonstrate whether production risks can be reduced through particular types of spacing and thinning as well as the timing of these silvicultural interventions. This information will be crucial when evaluating increasingly adopted stand management approaches that rely on self-thinning in the early phase of stand development, in particular in hardwood forests. The outcome of this study should be silvicultural guidelines that explicitly address the quality and stability development of stands through particular thinning regimes.

European relevance and collaboration: This issue is particularly suitable for a European research activity, because it touches on a problem of European relevance, because many Forest Research Organisations in Europe can contribute through experimental sites and data for a range of site conditions. Research groups that could play a key role are: University of Freiburg, Forest Experimental Station of Baden-Württemberg, Forest-Experimental Station of Lower Saxony, BOKU-Vienna.

3.4.14 Silvicultural strategies for climate change adaption – stand density management

Positioning: Applied

Short Description: Silvicultural strategies focus traditionally on the optimisation of wood production, the resistance towards abiotic and biotic risks and some nature conservation benefits. However, the risks from possible effects of climate change are usually not considered in these guidelines in a specific way. While some adoption strategies such as changing the species composition may operate in the long-term to adopt to rising temperatures, other mechanisms are required in the short-term to increase forest resistance to climatic extremes such as droughts and storms. Stand density management through thinning may be one very effective way to increase the resistance of individual trees, but there is little to no evidence, how this can increase the drought resistance of forest stands. To study this, various thinning trials that exist for different species could be sampled to analyse the response to the drought in 2003. Analysis may comprise tree ring analysis on trees of different dominance status across thinning treatments, located along climatic gradients for the specific species.

Justification: Through this study it will be possible to demonstrate whether production risks can be reduced through particular types of spacing and thinning as well as the timing of these silvicultural interventions. This information will be crucial when evaluating increasingly adopted stand management approaches that rely on self-thinning in the early phase of stand development, in particular in hardwood forests. The outcome of this study should be silvicultural guidelines that can explicitly address the management of drought resistance through particular thinning regimes.

European relevance and collaboration: This issue is particularly suitable for a European research activity, because it touches on a problem of European relevance, because many Forest Research Organisations in Europe can contribute through experimental sites and data, and because the European context allows the construction of climatic gradients from marginal to optimal for the different tree species under investigation. Research groups that could play a key role are: University of Freiburg, Faculty of Forest and Environmental Sciences (Silviculture, Forest Growth, Meteorology), Forest Experimental Station of Baden-Württemberg, WSL-Birmensdorf, Forest-Experimental Station of Lower Saxony, INRA-Nancy, Swedish Agricultural University, and additional institutions in Poland and Italy to permit construction of west-east and north-south gradients.

3.4.15 Silvicultural strategies for climate change adaption – mixed-species stands

Positioning: Basic

Short Description: The creation of mixed-species stands is often advocated to increase the resistance towards ecosystem disturbances and stresses in general terms. In the specific case of drought resistance, however, the effect of a mixture on the less drought tolerant species through competition within the rooting zone has not been studied. In this case, a species mixture may render a less drought tolerant species more at risk from drought through a more shallow rooting pattern in mixture. Thus while part of the stand may be more tolerant towards droughts, part of it may be less tolerant. This will largely depend on the stratification of the root systems. The knowledge about the stratification of root systems between different tree species is rudimentary at best and there has been no systematic assessment of the influence of site on this. This issue should be studied for important species mixtures along climatic gradients and also on different soil types. Fine root profiles should be investigated in the field using new approaches to distinguish the roots of different species, and experiments under controlled conditions (rhizotrones) are required to investigate the mechanisms in fine-root growth that lead to the stratification of root systems.

Justification: Through this study it will be possible to demonstrate whether production risks can be reduced through particular types of mixed species stands. This information will provide important background information for the general push for more mixed species stands. Results of this study will help to identify, on what types of sites these mixtures can increase the drought tolerance of forest ecosystems, and where they may have adverse effects on one (or possibly both) species. This knowledge is of fundamental importance for future silvicultural guidelines addressing climate change adaptation strategies.

European relevance and collaboration: This issue is particularly suitable for a European research activity, because it touches on a problem of European relevance, and because it can include many Forest Research Organisations that can contribute their expertise. Many of the relevant organizations are already organized in a COST Action on Woody Roots. Further the European context allows the construction of climatic and site gradients which determine the relative competitiveness of the species in mixture. Research groups that could play a key role are: University of Freiburg - Silviculture Institute, WSL-Birmensdorf, Alterra – Wageningen, University of Bangor – Wales, Technical University Dresden – Silviculture Institute.

3.4.16 Impact of silviculture and timber harvesting on sustainable site productivity

Positioning: Applied

Short Description: Every timber harvesting operation results in an export of biomass and nutrients from a forest stand, which can not be compensated on every site and therefore endangers sustainability. But there is still a lack of knowledge how different silvicicultural and harvesting regimes affect the export of nutrients from our forests on the long run. Only reliable nutrient balances for whole rotation periods can reveal the net biomass and nutrient export. Modern site-sensitive growth simulators extended with biomass and nutrient models can be used to calculate different scenarios of forest tending and timber harvesting on specific sites. This knowledge on the human induced output of biomass and nutrients from an ecosystem is the base to identify critical scenarios which can be avoided or counteracted in the future and to guarantee a ecologically sustainable timber production.

Justification: Sustainable land use and timber production is one of the main issues of forest management and topic of many international agreements like Rio and Helsinki. Market conditions as well as social concerns force forestry as well as timber industry to document the sustainable production of their products. For this reason concepts to ensure a sustainable production can be considered a prerequisite of forest management in Europe and a key issue for timber industry.

European relevance and collaboration: The problem can be considered pan-European and most relevant on poor sites. Because of the bid variety of sites and management systems we have to find concepts to guarantee both sustainability of site productivity and timber production over entire Europe. Typically there should be groups involved which are able to calculate scenario simulations of forest growth and management over whole rotation periods and are able to connect biomass output to nutrient removal. So a mixed group of scientists dealing with soil, growth and yield, silviculture and harvesting is the best precondition for a succesfull research of this project. Possible Partners could be TU München, Chair of Forest Yield Science, Germany Forschungsanstalt für Waldökologie und Forstwirtschaft, Abt. Waldschutz, Germany TU München, Lehrstuhl für Arbeitswirtschaft und Angewandte Informatik, Germany INRA Champenoux, France TU Dresden, Institut für Bodenkunde, Germany BOKU Wien, Institut für Waldwachstum, Austria

3.4.17 Impact of climate change on wood quality

Positioning: Basic

Short Description: Wood properties result of from growing processes of trees. It is an indisputible fact that tree growth has changed dramatically over last the last 60 years in many regions of Europe. Many important wood properties are also subject to changes with temperature, precipitation and site conditions. At present we mainly harvest trees which were grown under other conditions than we face today and can expect for the future. For this reason we need reliable information on the raw material production and quality of the future by joining the scientific forces of climatologists, forest growth and yield scientists as well as wood biologists to examine the changes and provide the needed information to the timber, pulp and paper industry. The methods of choice should be scenario simulations of growth with modern stastitical and mechanistical growth models based on probable climate scenarios and real inventory data for different specific regions in Europe. Measuring and modelling of wood properties on micro and macro level depending on climate and site conditions will result in profound information. It is important that entire rotation periods can be simulated and the quantitative share of different quality classes can be assessed.

Justification: More and more evidence for a drastic climate change force us to think about the consequences on forest and tree growth as well as on the resulting wood quality. Raw timber quality is a key factor of productivity and economic return in timber industry. If the properties of wood change, all production processes and the resulting products will be affected seriously. This has great economic potential, is important for industrial competitiveness and has to be considered for strategic planning and technical innovation.

European relevance and collaboration: Climate change is evident all over Europe. Experts predict drastic shifts of local climates to more dry and hot or - in other regions - to cooler or more humid situations. The impact of a changing climate on forest growth and wood quality, particularly in a regional scale, is still unknown. This way, scientists of different countries as well as for different subjects (meteorology, ecology, forest yield science, wood biology, etc.) have to work together for a succesfull research. AdHOQ - working group on modelling of wood quality aspects TU München, Chair of Forest Yield Science, Germany BOKU Wien, Institut für Holzforschung, Austria TU München, Institute for Wood Biology Germany University of Helsinki, Department of Forest Ecology, Finland University of Antwerpen, Department of Biology, Belgium INRA Champenoux, France PIK, Potsdam, Germany DKRZ/ MPI Meteorlogy Hamburg, Germany

3.4.18 Wood properties of Picea Sitchensis and Pinus sylvestris

Positioning: Applied

Short Description: Understanding the benefits of stand parameters relating to the wood quality of growth and climatic conditions.

Justification: To have a detailed map of the wood quality either within the UK or Europe and to be able to determine by stand what the best use of the standing material can be used for. Either construction material, paper, or pallet. This is a very large work area where industry would need to be involved to direct the products that could be used.

European relevance and collaboration: More unified timber resource and specifications for inward investment to benefit timber prices and industry. Timber models from INRA France, timber testing from STFI Sweden, and Frieburg Uni.

3.4.19 Log Tracking

Positioning: Applied

Short Description: In order to optimise the use of the European forest resource it is important that logs can be tracked from the forest through to processing. In this way information at each stage of the processing chain can be accumulated to provide processers and users with the maximum information on the material they are working with.

Justification: Tracking of material by coding is one way of ensuring that the properties of the material stay associated with the material and are not lost at each stage of the processing cycle. Accumulating this knowledge allows more refined decisions to be made about how to treat and deal with the material. This can reduce costs by avoiding expensive processing (e.g. sawing and drying) of material that does not warrant this expenditure. This avoids unnecessary transport of material that will be rejected by one process because it is only suitable for another process. Costs (financial, pollution, carbon, traffic etc.) are all potentially reduced

European relevance and collaboration: The European wood industry is very integrated with logs, pulp, chips, sawn products etc. moving across Europe. Avoiding transport of unsuitable material is important to reduce costs and increase competiveness.

3.4.20 Impact of silvicultural treatment on wood quality

Positioning: Applied

Short Description: Silvicultural management is a key factor for timber production, because bad shaped trees are eliminated and the timber properties of the remaining trees can be influenced by regulation of stand density and mixture. The last decades brought new silvicultural challenges like the conversion of monospecific in mixed and structured forests or tendencies to single-tree focussed thinning regimes with extremely short rotation times. At the moment we mainly use timber from trees which were grown under conditions of the traditional silvicultural concepts and we lack knowledge on the resulting timber properties of trees produced under actual management regimes. For this reason we need reliable information on the raw material of the future. The impact of silviculture on wood properties can be analysed by modern growth simulators joined with wood quality models which provide scenario simulations of different silvicultural regimes. The key is to understand the link between site, regulation of stand density and mixture on the one side and the resulting growth and timber properties on the other side. On this basis a corridor of optimal timber production can be defined which will serve as a guideline for the sustainable production of high-quality wood for the timber industry.

Justification: Changing social and economic demands as well as changing environmental conditions resulted in new silvicultural regimes which inevitably influence tree growth and wood properties all over Europe. Raw timber quality is a key factor of productivity and economic return in EU's timber industry. If the properties of wood change, the whole production process and the resulting products will be seriously affected. This has a big economic potential and has to be considered for strategic planning and technical innovation and therefore industrial competitiveness.

European relevance and collaboration: The issue of forest tending and wood quality has a pan-European character and therefore many groups already contributed to partial topics. What is still missing is a joint European approach of modelling the forest-wood-chain including detailed models for silviculture at the beginnning and coupling all these models until the end product. To include this in an operational simulation system which then can be used to model the actual tending management regimes should be a foremost objective on an European level. Institutions to participate would be: Chair of Forest Yield Science, Technische Universität München, Germany AdHOQ, Working group for wood quality modelling (international) FVA Baden Württemberg, Germany Institute for Wood Technology, Skelleftea, Sweden Prof. T. Pukkala, Finland INRA Champenoux, France Lehrbereich für Forsteinrichtung, Technische Universität München, Germany Institut für forstliche Arbeitswissenschaft und Forstbenutzung, University of Freiburg, Germany Sachgebiet für Forstbenutzung und Betriebswirtschaftslehre der Landesanstalt für Wald und Forstwirtschaft, Bayern, Germany

3.4.21 Characterizing stem wood and fibre properties at forest planning

Positioning: Applied

Short Description: New technology for measuring and characterising wood by efficient methods for forest inventory have a large potential to improve planning of forest operations. It supports development of optimized cutting plans, with respect to customers demands, economic and environmental cost/benefit analyses, demarcation of assortments and wood classes, destination, harvesting plans and logistics. Long term strategies for efficient, valuable and environmentally sound wood supply would also be supported. The planning perspective should be a full integration of forest operations into different industrial processes. This requires development of: • Methods to gather key information like breast height diameter, height and age of trees, frequency of damaged trees etc... • Models for predicting stem, log and fibre properties. • Decision support systems combining characterized wood properties, customer's demands and efficient logistics maximizing the net-value of the sum of all the industrial value chains that are to be concurrently served. Methods for data acquisition could be developed by testing different existing techniques (remote sensing, laser, NIR, callipering, image analyses etc.). "New techniques" could be also tested. Development of models could be based on existing databases and field studies. Decision support systems should be built on simulation techniques and algorithms for optimization.

Justification: There are large economic and environmental potentials in a consistent, reliable, well defined and cost-effective selection and supply of wood adapted to different products and processes. Wood supplies integrated into different products have the potential to improve production efficiency and to increase essential quality properties of final products. Development of measurement systems and models predicting stem wood and fibre properties of industrial relevance are most important issues to achieve real improvements in the forestry-wood chain. For example, the numbers of approved units of a product per m³ of wood raw material could be raised and/or higher product quality and sharpened standards for structural timber, paper products etc… Lower costs and higher revenues and less emissions, at the same time meeting customers demands will considerably increase competitiveness of wood and fibre based products. This will increase the use of environmentally sound wood and fibre based products of gain for the whole society. Preconditions: Use of existing knowledge, adaptation of inventory and planning systems. Use of standard information for forest planning.

European relevance and collaboration: The markets for forest products and timber are international. Common systems for forest planning would improve the market for development of affordable planning systems and methods for data acquisition. Possible partners Skogforsk, SP Trätek/LTU, STFI, SLU, Sweden, Metla, VTT, University of Joensuu, Helsinki, Tampere, Metsäteho, Finland, Skogforsk NO, NTI, Norway, AFOCEL and INRA, France, Forestry Commission, UK, KVL Denmark, Institut für Bodenkultur Austria, FOBAWI Germany. Manufactories of systems for planning of wood supply, forest inventories etc…

3.4.22 Estimation of wood and fibre properties before and during harvesting

Positioning: Applied

Short Description: The objective is to apply models for important wood and fibre properties for estimation of properties before and after harvesting. For Norway spruce and Scots pine in Scandinavia, a set of models for wood density and fibre dimensions have already been developed. At an early stage of the project, these models are used in prototype applications and improved based on the experiences gained. One line of applications is the introduction of estimated property information into forest inventory data. Based on this, new tools for planning in silviculture and harvesting are developed. Another line of applications is on-line estimation of properties in logs during harvesting. Based on this, tools are developed for more optimal allocation of wood and fibres to different industries and products. In parallel with these efforts, models and tools are developed for other wood species and conditions relevant for other European regions. The tools are adapted for different forestry regimes, including new regimes such as continuous cover forestry and other measures taken in consideration to environment and social impact.

Justification: The project would result in increased emphasis on wood and fibre properties in forestry. It would bridge the gap at the interface between forestry and industry by offering properties as a common language between the two. This would be supported by the introduction of property information in forest inventory data and new tools for planning in silviculture and harvesting and by on-line estimation of properties in logs during harvesting and tools for more optimal allocation of wood and fibres to different industries and products. This will be beneficial for both industry and forest owners. It will also increase the competitiveness of European forestry and industry.

European relevance and collaboration: The approaches outlined have been illustrated and partly tested in different applications by Skogforsk and by STFI-Packforsk. These groups have also good channels with industry and suppliers for the implementation of the project results. Similar ideas are also worked upon by researchers and suppliers in other countries. On a European level, contributions could also be made for instance by Forest Research Scotland, AFOCEL and Freiburg University and by supplies of harvesters.

3.4.23 Tree Ecophysiologist

Positioning: Applied

Short Description: Research into low impact silvicultural systems to ensure minimum soil disturbance to maintain soil carbon status "carbon forestry" The whole operational silvicultural chain needs investigated to ensure sustanability issues are at the forefront of all activity. Requires measures of carbon stocks and fluxes.

Justification: enables truly sustainable forest practice to be developed and implemented as the normal operating procedure.

European relevance and collaboration: Low impact silviculture is the historical management legacy of some \EU nation states whilst others are only beginning. It is of specific importanmce and interest to countries with high carbon content (peat) soils. The existing CarboEurope cluster in addition to nation state forest research institutes would be well paced to tackle this research

Sub-area 3.5 Optimizing the raw material supply chain for specific products or demands

3.5.1 Economic relevance of internal labour in small scaled forestry

Positioning: Applied

Short Description: About 46% of the 10.700.000 hectares forest area in the Federal Republic of Germany is managed by private forest enterprises. One third of these enterprises are smaller than 50 hectares with characteristic small-scaled management units. The general condition for these small-scaled forest enterprises have changed fundamentally within the last two decades. The economic development is extremely difficult. The ownership structure and the objective targets of many, primarily urban forest ownerships change continuously. The owners reduce their internal labour and silvicultural activities, try to submit the management responsibility to other organizations or tend to adjust the classic management at all. These results in combination with insufficient wood harvesting technology in low profitability, the usual wood structural practices hardly anymore practicable in the future. For example the possible increase of forest utilisation by 2 m3 per hectare and year the small- scaled forestry set about 3.000.000 m3 of rough timber aside for the commercial use in the wood industry. The negative effects of this trend on the developments of rural regions be hardly to assess. Prerequisite for the development of instruments which seem suitable for the mobilization of these rough timber reserves is the knowledge about the exact business and owner structures, their dynamics as well as its inner and outer influence factors, which shall be analysed by statistical and social scientific methods.

Justification: The meaning of the cluster forest and wood in Germany is already stressed considerably in various well-known studies. Decisions affecting sustainable forest management shall be based on a differentiated knowledge of forest ownership structures, particularly its dynamics and influence factors like development, range and costs of typical equipments or the trend of internal labour workload. The relevance of the small-scaled ownerships the into cluster forest and wood doesn't fade only in Germany but also in the rest of Europe.

European relevance and collaboration: Already numerous scientists and working groups have dealt with the extraordinary significance of forestry and wood industry for the development of rural regions in Europe, which are characterized by high rates of unemployment, narrow occupational bases, poor new job opportunities and raid emigration. By foundation of an international research network the previous research results could be collected, experiences exchanged and synergy effects used. This research network is especially important for the European forestry policy priorities, which has to deal with rural development, employment and income in rural areas, increased utilisation of forest products, renewable energy and climate change aspects.

3.5.2 : Wood harvest in the steep, drivable terrain

Positioning: Applied

Short Description: The last decades the essential framework conditions for a sustainable successful forestry have fundamentally changed in Central Europe, which forces the forestry enterprises to a "continuous" rationalization of all operational processes to save their business success. The search for ecological sustainable and economic competitive utilization methods for the renewable forest resource is essential for forest enterprises. A special challenge represents the wood harvesting in steep mountainous areas, which can be managed only with great technical and financial effort. Consequently the management and utilization intensity in this areas sinks, care delays in the stands arise and enormous rough wood stocks accumulate. For the economic acceptable mobilization of those biomass reserves efficient part and full mechanized harvesting methods must be established which increase the productivity, reduce costs in the forest operations and environmental impacts to an acceptable level. For the optimization of the use of alternative self-driving machines and technical systems decision support and planning instruments should be developed, which integrate specific machine criteria, special location and stand parameter to decide about the maximum tolerable slope of mountainous forest areas.

Justification: By the development and implementation of significant machines and location specific indicators (about slip measurements and friction coefficients) for the regulation of a limit slope for the use of self-driving work machines into extremely steep situations the discussion about the limit slope of different wheel or crawler undercarriaged machines can be based on scientific analyzed facts. Furthermore by developing decision support and planning instruments forest enterprises can be helped to increase the productivity by decision to efficient working systems with high level of mechanization. By implementation of modern information and communication technologies into the decision support systems and the supply chains it will help to improve profitably and competitiveness of forest enterprises at all.

European relevance and collaboration: A competitive management of limit locations is in all European countries of importance. Particularly for the new countries like Poland or Hungary radical changes are estimated, if wage the costs increase. Working methods which are marked by high shares of manual activities which were usually used before the EU joining are dispelled by part or full mechanized processes in future. By foundation of an international research network with this counties the previous research results could be collected, experiences exchanged and synergy effects used. The technological development can be integrated with relevant biological and eco rough wood stocks nomical research areas.

3.5.3 The contribution of forestry related SMEs to European regional sustainability

Positioning: Basic

Short Description: To a large part, forestry operations and wood processing in Europe is based on the works of rural small and medium enterprises (SMEs). These SMEs include, inter alia, smaller and larger private forest owners, forestry contractors and saw mills. Many of them could be classified as micro-enterprises, consisting of less than ten employees. Whereas agricultural enterprises, especially farms, are studied exhaus-tively by scholars of rural studies, especially of rural sociology, the knowledge about the social and economical situation and the working conditions of forestry related rural SMEs is comparatively small. The same is true for research about the role they play for the maintenance of forestry in Europe. One interesting approach for studying SMEs could be to look at regional sustainability, comparing different European regions, each with a high amount of forestry. Such a comparative case study could be done interdisciplinary; combining (a) methods of sociological re-search (e.g. in-depth interviews, questionnaires) to gain knowledge about the strategies and working conditions in forestry related SMEs in a region, with (b) network analysis and with (c) macro-economical approaches to analyze the eco-nomical impact of these SMEs and the value gained in the region.

Justification: In discussion sustainable development for Europe, sustainability is often either seen as attribute of single enterprises, of value-chains or of products. In contrast, the approach of regional sustainability or regional sustainable development allows looking at social, economical and environmental sustainability as attributes of a region and of regional economical networks, clusters and processes. As results of research as outlined above (a) it will be possible to identify successful strategies for the integrated sustainable development of regions with a high amount of for-estry; (b) also preconditions for successful regions will be identified; (c) the de-velopment of such strategies in other regions – enhancing their competitiveness – could be promoted and catalyzed. In a nutshell: It is important to look at the social and economical situation of SMEs often over-looked to understand the socio-economic impact of forestry and wood-processing industries in Europe, especially under the conditions of globalized timber markets and advancing concentration.

European relevance and collaboration: Historically, forestry and wood-processing industries in Europe followed quite different paths and trajectories. In the outcome, different economical and social configurations and strategies developed in European regions with a high amount of forestry. Under the conditions of globalization and of the common European market, these regions – and their differing strategies – can be understood as com-petitors. Only a comparative case study of regions in different parts of Europe allows identifying successful strategies for regional sustainability and their socio-economic and socio-cultural preconditions. Such work is done best in collabora-tion between research groups from different countries, each following the same methodology. At the same time, such work is interdisciplinary per se and should include scholars of rural studies, of forestry science, of regional economics and of sociology.

3.5.4 Integrated supply chain analysis for a sustainable & competitive timber sector

Positioning: Applied

Short Description: The research initiative aims at a modular and multi-dimensional analysis of exemplary forest-timber-chains in the wood construction sector in various countries in Europe. Together with businesses and associations, it aims at pointing out practical development possibilities for a competitive, ecologically compatible, socially fair and sustainable future and putting them into practice. For a long time within research and in practice, the timber chain has been understood as segregated parts, and hasn't been analysed in its entirety. This research initiative would analyse the chain coming from its two ends: forestry and the markets for final products. The development of a sustainable (in the broad sense of the word) timber chain, will signify a huge diversity for different chains in different regions of Europe. The initiative would try to compare exemplary cases in various countries, to point out panoply of possible developments, as illustrations of opportunities for other regions. As the aim of the initiative would be a sustainable, economically, ecologically and socially sound development of regions, an important part of it would be the development and testing of a new form of integrated consulting for the entire timber supply chain, which could then be applied to others than the case study regions.

Justification: Within the timber chain, we do not seem to have a problem of lack of technological innovations. They are readily available, but what lacks behind are organisational and institutional innovations. Their potential needs to be analysed and together with the various stakeholders, ways need to be found, on how to use them and make them applicable. Co-operative behaviour between the different chain links will be enhanced. Integratedness is a current problem for the timber supply chain. Information exchange and co-operation do not take place as they should. Looking to the entire chain, enhancing co-operation within the chain and analysing the potential for organisational innovations improve the competitiveness of the entire sector. Not only the forestry sector, but huge parts of the entire timber industry are closely related to rural development. Therefore, there will be a positive effect on the latter. Looking to entire chains, will allow for optimizing them, not only from an economic, but also ecologic perspective. The research projects in the various countries will only be successful, if they are well grounded in the regions, and are built on a participatory trans-disciplinary research process.

European relevance and collaboration: This research idea is particularly suitable for a European initiative, because many of the final products of the timber chain need to meet the same requirements over all Europe. This is combined with a particular heterogeneity within the entire chain, with a possible maximum of diversity at the beginning of the chain. It will be revealing to compare the differences in performance and to analyse their reasons. Central to the success of the research initiative is the combination of forestry vs. market, economy and sustainability oriented research. Therefore, it would draw on the one hand on a forestry related network, which results out of the COST action E51

"Integrating Innovation and Development Policies for the Forest Sector". On the other hand we would draw on a well established network of research institutes in the field of economic and environmental research (This research initiative is proposed jointly by the Institute of Forestry Economics, Freiburg, the Institute of Ecological Economy Research, Berlin (IÖW) and the Sozialforschungsstelle, Dortmund (SfS).

3.5.5 Building with wood – value chain from the environmental viewpoint

Positioning: Applied

Short Description: There is a growing number of environmental assessment tools developed for the building sector. The field of environmental assessment tools is vast. The existing tools are developed for different purposes and for different user groups. The whole chain (from production of building material to demolition and disposal of the building) should be harmonised. It is essential to understand how the different phases of the building's life cycle effect to the final results. The focus has to be on the whole chain. If certain parts are studied alone, this can lead to misunderstandings.

Justification: Integrated rules and methods should be developed in the EU level. The different methods and tools in different countries should be comparable.

European relevance and collaboration: This research is relevant for wood products industry all over Europe. Since the scope is wide, the collaboration between different research institutes and universities is essential. Partners in this research could be for example TU München, University of Hamburg, EMPA, BRE, KTH, VTT and TKK.

3.5.6 Parallel sustainable value chains of wood products and wood energy

Positioning: Applied

Short Description: Identification and evaluation of the techno-economic suitability of wood and forest biomass materials for wood products (sawn wood, wood panels, engineered wood), pulp and paper and/or wood energy products (forest industry, by-products of wood processing). Allocation of wood resources and by-product streams of forest industries based on wood properties and value, costs of the wood procurement - manufacture - distribution chain and subsidising policies. Basics and development of mass-based measurement techniques and commercial grading for energy wood (along with pulpwood and logs). The studies should include limited wood material science and timber measurement studies, but mainly modelling, simulation and optimisation studies, analyses of logistics and techno-economic competitiveness as well as state-of-the-art reviews and SWOT analyses (also against competing non-wood materials). The main data sources should be existing empirical research materials of the to-be-participating research organisations, or other exusting data bases, except for the necessary new wood materials. - Liquid ad/or gasified fuels from wood could be included in a way, if the scope of the studies does not then grow too heavily. However, this is probably an issue for large separate series of studies.

Justification: Analysis to help the discussion on wood allocation and cost competiveness between the aforementioned groups of wood users, and to define public support and subsidising policies. Analysis to help forestry and forest manaqement planning, wood procurement planning and focusing and strategic planning of wood uses. Analytical tools for the aforementioned issues as well as measurement, grading, standardisation and price-setting of energy wood (along with industrial wood). The studies are of the type of "applied basic research".

European relevance and collaboration: The theme is actual among the European pulp, paper and chipboard and related industries and wood energy industries which are interested in often use wood from similar sources. The results should contribute positively to the grounds and competitivemess of European wood products and wood energy sectors in the medium and long terms. The theme requires various competence and its developments from the participating research groups, thus, contributing to the scientific networking and competence within Europe. The nature of the research is mainly basic research, however, with direct links to the industry federations, industries and public stakeholders ("applied basic research"). See also the justification (before). Research groups in wood science and technology, forest technology, logistics as well as wood engineering and market/marketing research should participate in the implementation. Simultaneously, different economic zones of Europe should be included. I suggest research groups from Finland (Metla, VTT, Lappeenranta University of Technology), Gerrmany, UK and France.

3.5.7 Development of the economic potential by optimising the forest-wood-chain

Positioning: Applied

Short Description: A general issue of research of the institute are the potentials and possibilities of enhancing the economic situation of forest enterprises in Europe by an optimised forest-wood chain. Based on representative areas the potential for improving the economic basis of the forest/wood sector will be evaluated. Therefore the increasing of forest productivity, the aligning of timber supply and the demand from important market partners in terms of volume, assortments and qualities, and the improving of logistic components of the forest-wood-chain will be analysed. The research is focused on the following questions: • Which requirements have the sawmills related to sorting, volume, quality, time progression and logistics? • How can quality and quantity of wood supply according to the customer requirements be recorded, localised and concentrated? • Which possibilities exist to optimise the process of the forest-wood-supply chain among market partners? To develop sustainable concepts of utilization, it is necessary to employ the application of digital information systems for connecting the different interfaces "forest", "service industry" and the "wood industry". Therefore the development of IT-supported supply chain management systems is necessary, starting from area- and pile administration, routing within and beyond the forest and optimisation of the transporting system.

Justification: The results of this research project will enable the wood industry to exploit and develop their economic potential and guarantee the actual and efficient production of diverse products. Also it will be possible to rationalise the forest-wood-chain and to find efficient ways in organising the wood supply. The results of the project will be directly utilized by the stakeholders to improve economic results achieved by forest estates and sawmills within the framework of multifunctionally managed forests. The scenario-analysis on the impact on the diverse forest functions and landscape ensure that the enterprises' options for optimisation are consistent with the requirements of multifunctional forests. This is to ensure that the options are not detrimental to the sustained yield of these functions. Furthermore, the scenarios provide the public and political decision makers with information about future developments options for the forest/wood sector and thus further the involvement of potential public and private stakeholders. Particular emphasis is placed on the development of a tool for visualising the impact of different management strategies on the landscape level allowing non-professional stakeholders to make intuitive assessment of possible consequences.

European relevance and collaboration: The problem of increasing pressure on the economic sector in forestry is omnipresent in Europe. It is a common ambition to reduce dispensable costs in productivity and logistics. In addition natural damages like storms or beetles require the use of logistic systems which make a fast and mobile reaction in harvesting, transporting and supply of the wood industry possible. Therefore, dissemination of information among European countries is inalienable prerequisite to develop a high level in managing and dealing with wood raw material supply.

3.5.8 Characterisation of internal wood properties using Computer Tomography technology

Positioning: Applied

Short Description: Computer Tomography (CT) is a powerful, non-destructive technology which allows the identification of wood features relevant for wood and timber utilisation with high resolution and accuracy. The technology has already been introduced to the industry and will be increasingly used to support pre-sorting of saw logs and decisions taken on the appropriate production lines for specific raw material delivered to the mills. The technical progress aims to develop high speed tomographs for industrial utilisation. The identification, measurement and analysis of the wood features will depend on the quality of the underlying models for these characteristics from CT measurements. This research activity aims to develop high precision models for branch characteristics, ring width, reaction wood, spiral grain, and specific features such as coloured heartwood or abnormal moisture distribution.

Justification: The results will be high precision distribution models of any internal wood characteristic relevant to the wood processing industry for softwood and hardwood. The ability to decide the allocation of raw material to the appropriate production line allows a substantial increase in production efficiency, increase in quality of the product and in economic out-turn. Both forest industry and wood processing industries will benefit from CT scanning as an assessment tool of raw wood. The feedback from the scanning gives a precise knowledge base for the forest enterprise and forest owner for planning and management decisions, value of the resource and marketing with respect to the "quality" of their resource in relation to the targeted wood industry. For the processing industry, CT scanning will enhance the base of knowledge on the raw material and support the optimisation of the production both on a day-to-day basis and long-term. They gain a precise knowledge on the available forest resource in quantity and quality and will use it as a base for mid-term and long-term investment decision. All these aspects increase the competitiveness of the European wood sector and market share in timber trade.

European relevance and collaboration: Wood and timber trade requires homogenisation in standards and specifications which will be supported by a broad knowledge on the European wood resource to make the European wood sector more competitive. This research activity is particularly suitable for collaboration on a European level as the forestry and wood processing industry becomes increasingly internationalised. Currently, all world-leading producers of wood scanning machines are located in Europe. Several teams in Scandinavia (Trätek Sweden, Lulea University Sweden, VTT Finland), Joanneum Austria , INRA Nancy France, Forest Research Great Britain and Forest Research Institute Baden-Württemberg Germany are already involved in the development of suitable scanning systems and the development of the necessary algorithms for interpretation of the data. These different approaches should be combined and synergistic effects used to improve the developmental advantages situated currently available in Europe.

3.5.9 Ways to use the wide diversity of Guyanese tropical forest.

Positioning: Basic

Short Description: Each time a small forest area is cut in French Guiana there is more than 100 species to use in order to limit waste. The use of material selection softwares associated to wood properties database and wood piece marking is a way to cope with this diversity.

Justification: Due to the fast growing of Guyanese population significant forest area will have to be clear cut for urban and agricultural development, thus leading to a great quantity of felled timber. The optimum valorization of these timber for lumber, veneer, fuel ... is a way to help local development of activities an employment.

European relevance and collaboration: Expertise is existing in different european countries for wood product marking from forest to market (Scandinavia) and in materail selection softwares (UK). Moreover Europe is a market for tropical species with naturally high bioresistance and stability.

3.5.10 Aesthetic features of wood and wood products.

Positioning: Applied

Short Description: Wood is biological material with inherent variability which is a disadvantage in the production process. However, this variability gives wood products aesthetic features that are very interesting from an end-user point of view. The knowledge level about how to benefit from this competetive advantage is though very low today. The main objective of this research agenda is to gain better knowledge how to measure people's attitudes towards visible wooden features and wood products and how this information shall be transfered and utilised in the the wood value chain so an optimal control of the manufacturing process can be achieved.

Justification: This will create a better connection between the market and the forest in the wood value chain. It will enable the wood industry to survey the attitudes of the end-user of their products and also enable the industry to develope and control automatic manufacturing processes based on advanced scanning techniques and process control algorithms.

European relevance and collaboration: The market survey method and tool has to be adopted to different cultures and languages so it is very important that the work within this research agenda is carried out in a trans-european environment.

3.5.11 Monitoring wood chain processes to optimize and control value-adding means

Positioning: Basic

Short Description: Many sensors and measurements in the industrial wood process are used for feedback, control, measurements, grading and equipment performance. Machinery are often treated as sub processes and only extremely skilled personal and management can add them to a holistic overview to understand the process performance due to variation in raw material and end-user demands. Optimization is often performed on sub processes and hardly connects the value adding stages to a smooth system utilising all resources to a sustainable moneymaking body. To obtain such a system at least three components are needed: Feedback from the resources; A dynamic database- simulator; Tools for experimental design. Having these components a virtual optimization of process can be done and thus making process monitoring by predictions possible. Wood spider is a mobile system, connecting the sub processes by sensor fusion from scalar, 2-D and 3-D sensors defined in room- and time coordinates. Multivariate statistical process control tools are then used to monitor the process. The system can be used in two stages: As a research tool and for online everyday use in the factory.

Justification: New tools for process control simulation and optimization are developed and used in process industry. This can be transferred to the wood value chain especially sawmills have a process based flow and performance. Sensors for point measurements, two and three dimensional measurement are developed and used. The information obtained is used for controlling processes such as quality control, positioning, volume or value optimization and grading. As a side effect other information can be obtained such as machinery control, tool wearing that brings feedback from the process resources. This project has the goal to utilize the new technology developed for mobile communication, sensors and simulation technology to create a user friendly tool for taking control of the factory. To earn money today our European wood industry most be able to optimize the production, which means reaching for optimal conditions, making more precise decisions and deliver more consumer designed products. This is a dangerous situation if your actions can’t be visualized and learned from. The system parameters have to be connected otherwise a good selling might end up in severe problems in the raw material supply or crashes in the production system. This is what is happening today in many sawmills.

European relevance and collaboration: The European forestry wood chain must be innovative and sustainable. This means that the future industries are learning organizations earning money from knowledge based processes, fulfilling customer demands utilizing a sustainable raw material supply. To get there sensor and system suppliers must interact with the process modelling and optimization development. To get the wood communication from customer to the forest, flexibility and possibility integrate “old” industries, new IT and mobility solutions must be used. The key roll in this Wood spider system are played by the Wood technology/Wood metrics group and mobile communication group at Luleå University of Technology (LTU), SP/Trätek in Sweden,

VTT in Finland, JOANNEUM RESEARCH in Austria, Università degli Studi di Padova (UniPD). From the sensor perspective Rema Control and Innovative Vision in Sweden, Satimo in France, Microtec Italy are important R&D partners.

3.5.12 Optimisation of business and process chains for the wood industry

Positioning: Applied

Short Description: Necessary standards provided, the RFID technology can be used across all participating companies (producer, supplier, sub contractor etc) to support and improve logistic processes. Taking into consideration the critical and decisive factors for success such as time, quality and costs the integration of RFID technology can be used to effectively redesign logistic processes. It provides different options for the companies to design internal (in-plant) and external interfaces and by doing so optimises the entire logistic process. Existing technology can be adapted and used to model and optimise the business and process chains for the wood industry bey integrating forest related branches and utilisation chains for a holistic use of raw material. This is especially relevant to the modelling and optimisation „o of the flow of information based on a digitalisation of all relevant transactions regarding all the goods accompanying flows of information on the one hand and the integration of European standards for RFID-systems on the other hand „o of the material flow in order to implement strategic bundling of resources and products „o of the flow of value by documenting the responsibility for all participants through the use of RFID along the entire value creation chain

Justification: The following developments should contribute to an improved industrial competitiveness and market position of all participants of the wood processing industry: „o the use of integrated data organisation based on compatible data formats and structures along the entire value creation chain „o the development of a continuous and computer integrated use of data across borders and alongside the entire value creation chain covering the spectrum from raw material over product design and production to the finished product and its disposal Furthermore there are numerous opportunities to enabled important innovations: - synchronisation of the flow of material-, information and value - meeting the industries demand for raw material through just-in-time supply - fewer mistakes regarding the transmission of information - improved transparency of the logistic processes - easy connection of the participating companies information technology - reduction of cycle time by eliminating unnecessary processes (automated reading and identification of a group of articles) - improved transparency in the flow of material, information and value - minimisation of customer claims by avoiding missing parts wrong transports - improved traceability of certified types of wood and products (tracking and tracing) - improved customer satisfaction by reduction of the time for delivery The direct integration of data into the material flow, the fast exchange and update of data as well as the identification and tracking of products can be achieved through the use of mobile data memory (RFID technology). Thus an easily accessible documentation of important product information that remains with the material itself can be generated.

European relevance and collaboration: The research project provide a European-wide means of control of material flows from the renewable raw material wood to the potential recyclable through the integration of innovative technological components (e.g. RFID),

new forms of organisation (e.g. innovative bundling strategies) and the establishment of pan-european standards. Due to the volume of the planned research project the members participatng in this project should cover a wise range of major competences such as multi competent team: RFID specialists, wood processing companies, trading companies, consultants (process optimiser.

3.5.13 Modified fibre refining and fractionation to improve paper/board properties

Positioning: Applied

Short Description: An optimum combination of fibre refining (to modify the fibre properties) and fractionation (to separate springwood and summerwood) has a very large potential to increase the fibre value, by producing improved paper/board products. Refining may be undertaken before or after the fractionation. The production of paper/board then has to be made in a stratified way, either by bringing separate layers togeher, or by applying stratified headboxes (which also involves new paper forming developments).

Justification: The improved fibre value may be utilised by a lower fibre consumption,by a decreased energy consumption (especially regarding mechanical pulp), by usage of a less expensive fibre raw material, or by all these effects. The applications apply to all products, such as tissue, publishing paper, copy paper,liner board and other board products

European relevance and collaboration: The involved areas of fibre refining and fractionation, as well as paper forming are important at many European companies (Metso Paper, Voith Paper, Noss), institutes (STFI-Packforsk, KCL, VTT, CTP, PTS) and universities (KTH Stockholm, HUT Helsinki, TH Darmstadt). The STFI FEX pilot paper machine is useful both for the development of the different stages and for final concept evaluation. ,

3.5.14 Techniques and methods to predict tree material properties already by the forest inventory

Positioning: Applied

Short Description: Techniques and methods to predict tree material properties already by the forest inventory.

Justification:

European relevance and collaboration: Groups in Sweden, Norway, Finland and France

3.5.15 Flexible automatic wood products manufacturing systems

Positioning: Applied

Short Description: Wood is a biological material with very big variability. This is a competitive advantage for wood in products where the wood material is displayed visible. The variability of wood is however a disadvantage in the manufacturing process. This problem has so far to a great extent been solved by skilled workers in the wood industry companies. Today we can face that the European wood industry can't compete with low cost countries if they don't change from the labour intensive production processes to flexible automatic processes. This research issue is based on the possibilities that new achievements within the field of sensor- and information technology have developed in recent years. Today it has become possible to treat the variability of wood for manufacturing of high quality wood products in full production speed with aid of modern techniques. The objective of this research issue is to study how modern technology shall be used in order to achieve flexible automatic wood products manufacturing systems. The big challenge is to control the variability of wood in full production speed. In this work expertise from different areas like wood technology, scanning technology, production, wood machining, design etc. is needed.

Justification: How different sensors based on electromagnetic waves, sound, etc. interact with different wood features is one important research issue. A second issue is to study and develop automatic controlled wood machining processes based on feed-back monitoring. A third issue is to connect different sub-processes to a holistic system. A fourth issue is to study how a real flexible production for small series can be achieved. A fifth issue is to adapt and demonstrate virtual methods for product and production system design to the wood industrial reality.

European relevance and collaboration: The labour costs in Europe are relatively high. The only way for the European wood industry to survive is to change from labour intensive production method to high-tech lean production methods. Following research groups will have key roles in the implementation of this research: Luleå University of technology and SP/Trätek in Sweden, VTT Finland, Frauenhofer Institute Germany, Loughborough University UK, University of Forestry, Sofia, Bulgaria, Sabanci University Turkey, INPL Epinal France, Università degli Studi di Padova Italy .

3.5.16 Optimal selection of wood raw material according to aesthetic demands

Positioning: Applied

Short Description: In a normal wood product manufacturing process several different companies are involved before the end-use product reach the consumer. In long manufacturing chain there are difficulties to communicate the consumer demands. This is especially evident for the aesthetic features of wood. The problem is emphasized by the fact that several of the companies in the manufacturing chain are located in different countries with different language and different culture. Despite many wood products companies are SME:s and many of these have a very high share of export. It is evident that there is a lack of methods and tools for acquisition of peoples preferences for different aesthetic features of wood products and for communication of the market demands backwards in the manufacturing chain. The research regarding aesthetic features of wood and people's preferences of wood has so far been rather limited. Some studies have been carried out both in Europe and Japan, the lack of knowledge in this field is very evident. It is not quite clear which methodology that should be applied. However there are other product areas such as food and wine that have the same kind of questions. Methods and knowledge from these related fields will within the project be adapted and modified to fit in the wood product field. This will be a completely new way of thinking and working for the wood products industry.

Justification: In this project are developed and tested a methodology/tool for acquisition of people’s preferences for different aesthetic features of wood products with visible surfaces and transformed people’s subjective preferences to objectively measurable parameters. This tool will improve the competitiveness of the wood products companies as it will enable a more optimal selection of the wood raw-material. This is very important as the raw-material cost is often a big part of the total costs. The tool will also improve the possibilities and quality of the communication between different companies in different countries as the tool will be based on visualisation technique. SMEnterprises account for 90 per cent of the employment within the wood sector. The companies are often located in rural areas with high unemployment. An increased consumption of wood products with visible wood surfaces will increase the value yield for these companies and also increase the added value. This implies that the number of people involved in the production process will increase. The project will contribute to technology transfer to rural areas and less developed regions. In the project the wood surface feature measurement has be solved in an objective way with different scanning techniques and it has be solved also relations between the objective measurements and people's preferences.

European relevance and collaboration: Traditions and culture differ much between the European countries. These differences are also reflected on how wood is used and how much wood that is consumed in the different countries. The consumption of wood per capita in Finland is for instance five times as high compared to the consumption in Germany. It is quite evident that there are some differences regarding people’s attitudes

towards wood between different countries. In the proposed project a tool for measurement of people's attitudes towards visible wood will be developed and adapted to the some countries. The results from development work and from the market survey will help the wood industry in Europe to adapt their products and their marketing efforts to people's preferences for wood in different European markets. Another side of the European dimension is that the project includes different species; Scots pine, Norway spruce, Birch, Oak and Maritime pine. This mixture of species reflects really the differences regarding growth conditions and climate within Europe. The mixture of species includes both common softwoods and common hardwoods from both the north parts and south parts of Europe respectively. R&D partners: LTU, VTT, Fraunhofer, BRE, CTBA. Companies: sawmills with a 3D scanner a board scanner and X-ray Log Scanner. Manufacturers of edge glued panels. Companies which have cross-cutting line with scanning equipment and furniture manufacturers.

3.5.17 Optimization of recycling potential of recovered papers:

Positioning: Applied

Short Description: Renewable bio-materials have a unique combination of being recyclable and reusable for new products and for energy generation. They are bio-degradable and able to substitute for both products and energy. Further im-provement of the already good sustainability standing of the forest-based sector is an important challenge.

Justification: Creation of increased consumer awareness towards recyclability of paper and board products, optimal collection systems and creation of an optimal legislative setting and striving for optimum recylability oriented product design • Improved collection systems optimized towards potential re-use of the collected paper and board. • Introduction of dry sorting techniques and on-line characterization methods for characterization of fibre potential and other compo-nents in recovered paper including new sets of trade standards to enable re-use of the paper constituents for the highest possible grades. • Development of new external re-use applications for the non-paper fraction out-side the pulp and paper industry with a maximum added value for society. • Development of concepts and tools for the optimized fibre raw ma-terial choice to create fitness for the purpose of recovered fibre based products = Modelling the optimal use of recovered materials (in terms of Ecology, Economy and Technology within Ecologic and Social boundaries)

European relevance and collaboration:

3.5.18 Requirements and specification of end-use-related properties and their quality control

Positioning: Applied

Short Description: Despite the recent investments of many million of euros made by the European sawmill industry to improved strength grading, surface defect appearance grading, kilning technologies and scanning equipment, there are still major problems that require addressing to improve the competitiveness of timber products with other materials. To fulfil the end-users' requirements it is important that quality control systems are available and are actively applied. To achieve this, quality control must be precisely defined, features for a particular product must be identified, limits must be established, accurate measurement systems must be developed and above all the systems must be widely used. The main approach is to define the requirements and improve the quality control of timber products and components to ensure fitness for purpose and optimal value. Studies include: · summary of the performance requirements for finished components/elements/structures imposed by society for safety and by commissioners for functional and aesthetic reasons, · inter-relationship between performance requirements and grading parameters of wood-based and timber products, · inter-relationship between grading parameters and important material properties which ensure that the specified requirements can be fulfiled, · review of quality control techniques for logs, boards, semi-finished wood products and their suitability for measuring parameters to facilitate quality control.

Justification: In order to stay competitive, the forestry-wood chain needs to increase its efforts towards improved methods of quality control throughout the whole production chain. The scientific programme focuses on supporting developments related to scanning for wood properties as well as assessment of wood moisture, distortions, strength, stiffness and visual appearance. By identifying new measuring and assessment techniques, this project will promote their adaptation to the specific needs of the wood products sector as well as support the development of reliable, cost-efficient quality control systems. It will also provide the basis for improved specifications for timber products and contribute to economic optimisation of production so that the full environmental and sustainability benefits of timber can be realised. The trend of increasing timber production is expected to continue. Neither consumers nor producers are aware of the wood properties which govern performance and, as a result, the current grading rules are more production-oriented than consumer-oriented. As a result, timber products are not manufactured as well as they might be, nor are they specified as they could be. Better define timber qualities (obtained in this project) which can be verified, is one of the conditions to improve competitiveness of the forestry-wood sector.

European relevance and collaboration: Within this project, collaboration is essential to gather and generate qualitative and quantitative knowledge about demands and expectations that end users in European countries impose on various timber products (objective and subjective requirements). It will be these requirements can be met by existing scanning techniques. Improved quality control systems will help to increase the

competitiveness of the wood sector, ensure that round wood is optimally processed and that European wood industry provides wood products which are well adapted to end user requirements. Identifying the performance and relevance of scanning, drying and grading technologies on the European level is essential to propose quality control techniques for wood raw material and wood products and their suitability for measuring parameters to facilitate quality control systems.

3.5.19 Optimizing the entire forestry-wood-construction chain in terms of wood quality

Positioning: Basic

Short Description: The quality of timber structures (buildings and furniture) is dependent on several parameters, such as loads, geometry, environmental parameters and the physical properties of timber. The important physical properties for structural timber are for example micro fibril angle, density, ring width, knot geometry, fibre directions and water adsorption. The timber quality in terms of physical properties are dependent on the treatment in the processing and on the conditions during the tree growth. The aim of this project is to create a series of models that can describe the quality of the timber in terms of physical and mechanical properties through the entire forestry-wood-construction chain. Each step in the chain has a set of input parameters that affect the timber quality. Some models already exists, others are missing or are not compatible. The main approach is to improve the existing models to be compatible with each other and improve these models also by including more parameters with better accuracy

Justification: In order to stay competitive, the forestry-wood-construction chain needs to increase its efforts towards quality of the end-product. By creating a series of models that are able to simulate timber products, and how they are affected during the entire production chain it will be possible to study the effect of changes in the chain on the quality of the final product. It will be possible to combine the models to see the effect of environmental parameters on silvicultural processes and how they affect the final quality of the timber structure, for example. When including also economic aspects into the model it will be possible to optimise the forestry-wood-structure chain in both qualitative aspects as well as economical aspects. It will also provide the basis for improvements along the complete production chain for timber products and contribute to economic optimisation of production so that the full environmental and sustainability benefits of timber can be realised.

European relevance and collaboration: Within this project, collaboration is essential to gather and generate qualitative and quantitative knowledge about the forest-wood-structure chain in European countries. Simulation models for the entire forest-wood-construction chain will ensure that efforts are taken to produce the right raw-material for the right end use without sub-optimization in each step. This will ensure that the European forest industry and wood industry can provide wood products which are well adapted to the end use quality requirements.

3.5.20 Optimisation of the Supply Chain

Positioning: Applied

Short Description: To remain competitive in a global market the best use of the wood and fibre resource in Europe needs to be made. Understanding how the way we manage our forests and how we process our trees affects product performance is critical. This requires a clear knowledge of the properties of the material at all stages of the ofrestry/woodchain. It means using models and the latest measurement techniques in an integrated manner.

Justification: Optimised resource allocation throughout the woodchain with reduced costs (financial and environmental) is critical to ensuring the sustainability of the European forest industries. At present much of the European forest industry is producing predominately a low value end product which could be improved by correct allocation of the raw material.

European relevance and collaboration: The European forest industry is already integrated (some companies work across Europe and material is transported across the region). Therefore, the research needs to be carried out and implemented at a European level and involve organisations covering all parts of the woodchain and including research organisations, industrial bodies, trade associations, governemntal and European agencies (e.g. EU)

3.5.21 Assessment of stem straightness on standing trees

Positioning: Applied

Short Description: Estimation of the green log proportion at the stand level using photographic methods. Measurement on stands before tree felling. Validation by direct log scanning on the sawmill.

Justification: The method can be a new forest measurement tool. By using stem straightness characterisation at the stand level the industry can develops better business plans. The chain timber to end product can be improved. The method can be used on forest management.

European relevance and collaboration: A collaborative European research activities gives a wide vison an the variation of the stem straightnes. Napier Univ.

3.5.22 Application of scanning technologies for timber selection

Positioning: Applied

Short Description: The work relates to methods by which defects such as knots, slope of grain and compression wood can be indicated by optical scanning and ways of minimising their impact, either by sorting or processing. Importantly, the research will look at the overall effect of the sorting process on timber quality. Aims: • Investigate potential to use optical scanning technologies on currently under-utilised European softwoods and hardwoods to add value and open new markets. • Development of sorting criteria aimed at new grading methods and to avoid processing material likely to be rejected during production • Linking silvicultural practice with sawn timber scanning and grading knowledge Project participants will assess under-utilised, low value and reject timber to determine physical properties, "scannable" features and effect of sorting strategy based on measurable parameters on overall out-turn. A realistic approach to sorting timber will be maintained, building on collective knowledge of timber grading principals. Research will be directed to determine within the forest, sawmill and processing plant opportunities for scanning processes, the nature of the image type available, together requirements for hardware and software for the detection system.

Justification: In order to determine what optical scanning techniques can be applied by the industry it is necessary to understand the effect of particular characteristics on timber performance. This can lead to the establishment of threshold values for processing decisions, and the development and evaluation of sorting strategies. This also allows the technical and practical difficulties of the scanning processes to be investigated. The research questions are: What are the variables that affect timber performance? Are the most significant variables log or batten related? How do these variables interrelate? Which timber variables can be measured by optical scanning methods? What are the practical difficulties in making the measurements? What threshold values should be applied? What is the overall effect of sorting strategy? Can logs yielding higher structural grade material be identified, Can logs containing timber prone to distortion be identified prior to conversion? Enhancement of timber scanning knowledge databases will be a key goal. A fundamental understanding of the modes of distortion in both softwoods and hardwoods will be gained by small scale and full scale testing to determine shrinkage values, effects of knots and disturbed or sloping grain. Relationships between tree shape and batten position within log will be determined by physical testing (stiffness and strength) on both full and small scale. From this enhanced knowledge base potential scanning techniques can be evaluated.

European relevance and collaboration: This project will contribute to a concerted European approach to the sustainable evolution of forests by encouraging increased planting and management of a diverse range of species, which will also increase biodiversity. It will help to increase the competitiveness and optimise the value of forest resources through the development of new innovative products made from under-utilised timber. Key European scanning and processing research groups would need to be involved including those in Germany, Sweden, Finland and the UK.

3.5.23 Knowledge on properties of European hardwoods for higher value products

Positioning: Applied

Short Description: The objective of the project is to improve the knowledge-base on properties of European hardwood species, providing a basis for the development of products with higher added value. A wide span of properties would be studied, of relevance for different sectors of the industry, including furniture, building components, paper, etc. A set of species of importance in some European regions are investigated, including typical variations within stems and differences between typical growth conditions. Different sets of properties are analysed by different research groups with efficient equipment, each set of properties by one group for total compatibility. The data are compiled in a database. Differences are evaluated from the perspective of various types of products. The results are disseminated to stakeholders through reports, articles and seminars, with special consideration to the needs of small and medium size companies.

Justification: The project will result in knowledge, which will provide a basis for the development of new and better products and more efficient production in different sectors of the wood-based industries. It may result in new designs, more functional products, better yield and reduced use of material, chemicals and energy, reduced volumes/weights to transport. All these factors may contribute to increased industrial competitiveness, better products for the end-users and reduced environment load. The results are expected to be particularly useful for many small and medium size companies. New work opportunities could be created or existing employment secured, not the least in forest regions, with positive side effects for the regional society.

European relevance and collaboration: Optimal use of the European forest resources in new products would be an important positive factor in the competition the industry is now facing form countries with wood raw materials from fast-growing plantations and lower labour costs. Efficient measurements are a key to the execution of the project. Two examples of instruments preferably used are a tomograph for scanning of the interior of logs and SilviScan. Research groups with expertise regarding the different hardwood species and their use have to be engaged. Examples of partners which might contribute are Växjö Univerity, STFI-Packforsk, SP, VTT, AFOCEL, University of Freiburg, Univerity of Göttingen and Forest Research Scotland.

3.5.24 Adaptive scanning for precise characterization of wood raw materials and products

Positioning: Applied

Short Description: The objective is to develop new adaptive scanning and measuring methods for surface and internal characterisation of wood raw materials and products in order to maximize value recovery throughout the forest wood chains. New systems are based on multisensor instead of single sensors and data fusion approaches integrated with smart optimization procedures. For the execution of the project several investigation platforms are implemented and equipped with different physical measuring instruments. Representative wooden samples, semi finished and final products are selected covering typical raw materials within Europe. Samples are measured using different measuring technologies providing data the development of algorithms for converting data into information and further to knowledge. Based on this basic research phase development of industrial scanning systems is executed. Important part of the system is the end user friendly human technology interface (HTI) providing effective teaching and learning procedures. Prototypes are implemented and evaluated in the industrial environment. The research is applied research oriented including basic reserach elements

Justification: Experiences concerning scanning and measurements in the industrial environment have clearly shown that the systems based on one single sensor i.e. RGB-, IR- etc. cameras can detect and recognize fairly accurately limited number of wood properties and defects affecting on the quality of a piece. Current systems are not flexible and number of control parameter values difficult the use of the systems. The present systems are not self learning. System to be developed can be configured according to the end-user's needs. Configuration is related to type of wood raw material, products and production facilities. This also lowers considerable the price of the system. The system will be provided by adaptive features supported by feed back procedures established throughout the conversion chain. This is not the case in existing systems. Innovation lies in the combination of single sensors together. Set of sensors produces data for processing based on data fusion and optimisation approach resulting qualified information for decision making. System will be provided by user friendly interface which makes possible adaptability and use of information throughout the conversion chain. New system ensures considerable improvement in the accuracy of detection and classification at low price of non homogenous wood materials and products. Increase of value yield is estimated to be at least 20 percent.

European relevance and collaboration: The overall target worldwide is to better use the value of available forest recourses and minimise the amount of waste. This target is relevant in all countries independent how important forest based industry is. The scanning and optimisation system presented in this research issue is a key tool for achieving considerably better value yield in the manufacturing. This research issue is particularly suitable for collaborative European research activities because wood raw materials, type of products, size of mills vary from country to country. There have been different approaches in the research field concerning measuring technology for wood.

Only joint European level consortium can achieve real progress in the scanning technology. The resulting system configurations can be adapted in different wood business areas within Europe. Key partners: VTT Technical research centre of Finland, Luleå technical university (Sweden), Fraunhofer institute (Germany), CTBA (France), University of Rome (Italy)

3.5.25 Virtual Wood Conversion System for improving profit

Positioning: Applied

Short Description: The proposed research project is aimed to develop a virtual wood conversion system - software - which imitates physically the entire conversion processes from the stems/logs to the final end products i.e. sawn timber, plywood. The system makes possible the impact assessment of different operation policies i.e. wood raw material allocation on the profitability. The input stem/log models to the software are based on real logs. The output products are modelled according to customers' specific need in the form of 3D sawn timber components, plywood etc. The software could visually present wood raw material, manufacturing processes and output products to give a sense of touching physical entities by eyes. Accurate numerical models of representing real logs and final products are essential for a successful virtual system. The log model is to include heartwood and annual ring feature, defects such as knots, and external shape etc. A 3D log visualization module is to be developed. The logs can be taken from online log scanning, or reconstructed with measurement data of sample logs. Products modelling will deal with both sawn products and plywood along with 3D product visualisation functionality.

Justification: The proposed Virtual Conversion System is a decision support system for operation analysis and management and its eventual goal is to facilitate decision-making and achieve better economical output. The benefits of Virtual System can be listed below: • Trial conversions to better match raw materials available with products demand at marketplace. • As a strategic plan tool for forest industry firms, e.g. feasibility study on sawmill / plywood mill etc. project under given or proposed operating circumstances. • Assess new products through test-manufacturing the newly designed products virtually with the system • Feasibility assessment of customer order based on available raw material resources, production capacity, and ordered products quality specifications. • As a marketing tool to present prospective customers visually the resulting products manufactured according to the agreed terms of product quality etc. • As a training tool for operating staff of sawmills. • As a research and development platform for a wide range of sawmill operation related researches such as real time sawing optimization, log positioning, impact of grading rule changes etc, just to name a few. • Supporting optimal allocation of wood raw materials throughout different conversion options.

European relevance and collaboration: Since technically the virtual system should be capable to deal with both softwood and hardwood tree species from various areas in Europe, collaboration within European countries is necessary simply for this sake. For instance, Germany and France could undertake hardwood log modelling task for the project, while the Nordic countries concentrated on modelling pine and spruce logs. The same logic holds true regarding exploitation of the virtual conversion system. A number of research projects have already been executed providing good starting point for the realisation of the project. However common European virtual conversion platform is still missing Equally important is the built-up of the cooperation network among EU projects partners and among the Nordic countries. The built-ups will greatly facilitate the

implementation of the proposed project. Potential partners: VTT Building and Transport, Finland; Luleå technical university, Sweden; University of Freiburg, Germany, BRE ,UK

3.5.26 Flexible and Adaptive Manufacturing Systems for the Production of Wooden Components

Positioning: Applied

Short Description: The objective is to is to developed knowledge based production systems for manufacturing precise specified wooden components in order to achieve considerable improvement of profitability, flexibility and adaptability. The targets are 1) decrease throughput time of a product to one day and 2) decrease volume of the storages by 90 percent and 3) increase value of the production by 25 percent. The project will integrate different expertise areas and research approaches such as 1) Wood factory planning, 2) Novel methods in wood drying, 3) Strength grading methods and modelling of the strength, 4) Modelling and scanning of biological durability characteristics, 5) NDT-methods such as log scanning, sawn timber scanning (X-ray, surface scanning etc), 6) Data acquisition and processing, knowledge management, 7) Advanced material flow control by using marking and identification techniques 8) Experimental research, 9) Structural design and codes and 10) IT, web tools. The execution of the project includes basic research providing information for applied research. Final output of the project is concepts, systems and demonstrators of flexible manufacturing systems for the wood products industries. New systems are implemented in industrial environment and demonstrated. Sustainability impact assessment will be carried out.

Justification: The current manufacturing methods of wood products can be described as follows: 1) Supply chain is not taking into account in it's entirety, 2) Manufacturing time may require weeks (months), 3) Storages are large, 4) "Falling" products which are not desired will be received, 5) Production is not flexible; emphasise minimising costs, 6) Business is not adaptive; feed back information is not used, 7) Information systems are not communicating, 8) Properties of wood products vary a lot, 9) Difficult to produce products with precise defined properties. The new flexible and adaptive manufacturing concepts to be developed will of considerable avoid the above mentioned bottlenecks and constrains. The results will be improve essentially competitivness and profitability of the wood conversion companies and impact positively on the sustainability indicator values.

European relevance and collaboration: The execution of the project needs a lot of input data regarding wood raw materials, products, manufacturing systems from European countries. The differences have been taking into account in the R/D work in order to develop solution covering wide range of needs and requirements. The project will support the transformation of European wood industry towards a more knowledge-based and added value industry. It will create a new generation of manufacturing concepts and improve the competitiveness European wood industries to a new level. It also enables more efficient use of renewable wood material and improves its competitiveness as building material. R&D partners: VTT Technical Research Centre of Finland; Fraunhofer, Germany; BRE, UK; CTBA, France, Luleå Technical University, Sweden. Industrial involvement: Sawmilling companies, machine manufactures, suppliers of scanners and information systems.

3.5.27 Tools for optimal use of wood and fibres in products and mills

Positioning: Applied

Short Description: For efficient production of high quality products in the industry, the raw materials used should have uniform, known and suitable properties. And different properties are needed for different products. The forest-based industry is, however, using natural materials with a large variability. There are differences between and within wood species, regions, stands and trees. Some of these differences are structured and can be used as sources for materials especially good for specific products, if the benefits exceed the costs involved. Other differences are not possible to predict. In pulp and paper production, their effects can to some extent be handled through mixing, but in solid wood products it is more difficult. In the project, inventory data and data from harvesters are used in combination with models to estimate properties of wood and wood cells at an early stage in the value chain. This information is used to allocate raw materials in an optimal way, considering available resources, product and process demands, benefits and costs. Tools are developed and tested to support different actions taken along the value chain, including assessment, selection, sorting/mixing and allocation. The tools are linked to optimization of the processing in the mill.

Justification: The project will result in more optimal use of the forest resources. Existing products may be further developed for new and improved properties and new products may emerge. The yield in the production processes may increase. It may bring result in reduced use of material, chemicals and energy in the production of the products, reduced volumes/weights to transport. All these factors may contribute to increased industrial competitiveness, better products for the end-users and reduced environment load. New work opportunities could be created or existing employment secured, not the least in forest regions, with positive side effects for the regional society.

European relevance and collaboration: Optimal use of the European forest resources in new products would be an important positive factor in the competition the industry is now facing form countries with wood raw materials from fast-growing plantations. There are strong European traditions in the research areas relevant for the project. Research groups at STFI-Packforsk, Skogforsk, AFOCEL, VTT and Forest Research Scotland have already cooperated in this field. These groups have also good channels with industry and suppliers for the implementation of the project results.

3.5.28 Reduction of log-end cracks resulting from growth stresses

Positioning: Applied

Short Description: Growths stresses in stems are characterized by external tension and internal compression in the fibre direction, which tends to induce heart cracks or ringshake after tree felling. Log steaming often performed in processing operations usually triggers the phenomenon. These problems are particularly pronounced in hardwoods in the case of tension wood occurrence; their cause real problems, for instance, for veneer production of high quality beech as well as fast-growing poplar. Mechanical modelling can help for the understanding of these problem as well as for finding means to reduce their practical consequences.

Justification: Optimisation of log felling and steaming, sawing methods techniques may increase the yield and reduce wastes.

European relevance and collaboration: Many European countries possess important hardwoods resources and are concerned with these problems. The recent advances of wood mechanics at European level could result in significant improvement in the processing methods

3.5.29 Head of Technical Development

Positioning: Applied

Short Description: This work is integral to the development of efficient forestry production systems. There is a need to identify current information gaps, identify specific information needs and then to identify an approach to meeting these needs in relation to information available or required.

Justification: Adding value to forest production is a core element to achieving UK forest policy. Social, economic and environmental benefits will accrue from such developments.

European relevance and collaboration: Information exchange/collaboration is essential to achieve the desired outcomes. most if not all European research will be relevant, particularly that from similar organisations to our own.

3.5.30 New data acquisition of terrain and vegtation canopy by linescan-sensor and laser-scanning device (full wave)

Positioning: Applied

Short Description: 1. Development of a prototype: device consisting of a linescan camera and laser scanning module (full wave) in one single unit 2. Software development for automatic vegetation recognition to detect timber mass (using full wave technology by Riegl®). 3. Up to now vegetation/forest recording/sampling has been made at field work (cost intensive) and was not available for large areas. This new hard- and software developement allows automatic recording of biomass area-wide, including all its additional forestral information. 4. Data processing of the results created by this new technology will be possible with any common software used in the GIS market.

Justification: Areal survey with this new combined camera unit provides all necessary data for forestral management. You get orthorectified areal pictures with different spectra (visible spectra - RGB; near infrared, pan) and in addition a digital surface/elevation modele of the investigated terrain These images are so called "true" orthorectified areal pictures, because all objects (houses, trees etc.) have a position accuracy of plus/minus 10 cm in horizontal direction. This accuracy is very important for forestral analysis to distinguish vegetation/forest types. Using the method of "full wave" all trees will be detected, also underneath the crown. It is necessary to develope a new software for recording and analysis to get the whole vegetation canopy splitted in classes of types of wood/vegetation and its mass area-wide. Using this combined unit (linescan sensor and laser scanner) for investigation analysis of vegetation canopy, deriving of surface- and digital elevation model is processed with one single areal survey. Terrestrial survey will be reduced to a minimum. The integration of this obtained data in existing software environments will support consulting organisations, for instance chamber of agriculture. These data can be used in special software management systems by forestral associations, large forest enterprises, saw mills and owners of small forests as well.

European relevance and collaboration: This method is the first to offers the possibility of capturing the biomass of wood all over europe, witch guaratees a better use of renewable biomass energy. The aim of the project is to tackle the problem of detecting unused resources of wood, especially the wood areas of small forest companies, without causing extraordinary expensis. The project will be carried out in cooperation with universities, companies developing remote sensing /laser scanning units and forestral associations in the European Community. The development will be carried out by Forest Mapping Management GmbH., Salzburg, Austria in cooperation with: Riegl-Laser Measurement Systems Ges.m.b.H. 3580-Horn University Joaneum Research Herr Prof. Schad in Graz German Aerospace Center (DLR) München und Berlin Forest association of Styria (Waldverband Steiermark) University BOKU (Bodenkultur) Wien University of Salzburg ZGIS Hr. Prof. Dr. Strobl

Sub-area 3.N Other

3.N.1 Land surface use strategies for sustainable supply of renewable resources

Positioning: Applied

Short Description: The change of the economy towards a renewable resource basis, requires the development of a land surface use strategy for a sustainable supply of renewable resources from agriculture and forestry. This includes the qualitative and quantitative analysis of land use demands and resource demands arising from renewables as well as the identification of ecological, economic and social conflicts and potentials regarding the use of renewables. Conflicts might appear regarding different land uses e.g. for environmentally friendly agricultural production, sustainable forest management practices, solar electrical energy, nature conservation, soil protection, water purification and protection, tourism.

Justification: Considering the increasing demand for renewable resources (e.g. for energy, fuel, nutrition, timber) and the limited availability of arable land resources a number of conflicts regarding the supply of different renewable resources are predictable. Research has shown that use of renewables might be related to higher environmental burden (e.g. depending on type of renewable, production processes, treatment, waste management or recycling), or social conflicts (e.g. in the area of genetic engineering). Consequently, for the smooth shift towards renewables the development of a land use strategies for sustainable supply of renewable resources is needed.

European relevance and collaboration: The European policies promote the increasing use of renewables and space use in a number of different policy arenas, including energy policy, environmental policies (including nature conservation, water and soil protection, climate) or agricultural and forest policies. For the efficient integration of these policies and management of related space use conflicts a European informational base for coordination is required. This can only be achieved by research at European level.

3.N.2 Effect of global change on wood supply in extreme environments

Positioning: Basic

Short Description: Climatic warming is taking place and has an exceptionally strong impact in extreme environments where trees grow currently in limiting conditions, such as the alpine and northern timberlines. For example in Finnish Lapland, tree growth has reportedly increased a lot during the last three decades. This creates a new situation and potentially provides a new source of raw material in areas that were barren in the past. However, more information about the growth requirements and conditions as well as the sustainable supply of nutrients is required in order to assess the long-term potential of such increases in growth, e.g., for bioenergy production. Approach: eco-physiology, silviculture, climatology, wood material science.

Justification: Contribution to competitiveness: assessment of new sources of raw material for e.g. bioenergy; sustainability of the resource

European relevance and collaboration: Applies to research in extreme environments: alpine and arctic research areas. E.g. Austria and Finland.

3.N.3 Restocking of Agrarian Marginal Sites

Positioning: Applied

Short Description: In future, restocking of landscapes agriculturally used for a long time will be an integral part of the environmental change in the European region. Inevitably, a reduction of the agrarian promotion will entail a retreat of agriculture from low-yielding sites. To this there is no alternative in view of the budgetary development of the EU and considering the continual overproduction of agricultural products. In natural succession and without any human manipulations, on those sites forest ecosystems forced back before would appear again over the medium and long term. The demand for a purposeful control of the proceedings has to be deduced from the multiplicity of the social requirements on the forest. Concerning this, conceptions are necessary which interdisciplinarily analyse the scenario of woodiness and contribute to an integration within the different spheres of influence on the basis of criterions that can be objectified. Essential aspects such as the variety of forest functions and the absolute compulsion to invest the financial resources effectively arise questions about the superficial area, spatial distribution as well as the way of restocking. Environmental requirements and the economical forest utilization are mutually influenced in this connection. Time frame: 2008 – 2013 Budget indication: 1,25 mio. €

Justification: Expected deliverables: Forest economic reclamation strategies as a contribution to forward management of land utilization on the European scale. Reduction of the agrarian promotion Reduction of the agricultural production Positive effects on the preservation of resources (protection of soil, climate and biodiversity) Sustained production of resources concerning wood and cellulose industry (EU in the capacity of a net import region for wood and wood products) with regard to the utilization function Alternative economic branches of rustic family holdings Economically and ecologically significant advancement of rural regions More extensive land utilization by means of environmentally compatible production strategies Preservation of places of employment in weakly structured regions The outlined project goals are identical with the basic ideas of Vision 2030. By outlining of integrative conceptions to increase woodland a special responsibility is equally taken into account as it results from the multidimensionality of the forest functions and has to be called in the sense of generation justness. By that, harmonized strategies for further land utilization in a common Europe form the planning basis, and reclaimed forests will take up a determining component in it.

European relevance and collaboration: The project is of outstandig importance to the further environmental management in the European countries. Considering the wordwide increase of wood consumption, the restocking of agrarian unproductive sites by natural succession or reforestation is the most important way of alternative land utilization and advantageous on ecologic and economic grounds. The project is drafted as a multidisciplinary research approach which is highly practice-oriented and including all the relevant stakeholders. Facing the international significance of this theme, from the beginning frontier crossing solution approaches are the focus of research activities. Reputed institutions from science, economy and from the responsible authorities join to

the project network. Besides forest sciences, landscape ecology and economy belong to the participating disciplines on the scientific level. Various groups of land users, representatives of forestry, timber trade, industry and of the administration participate in the formulation of the criterion catalogues and of the goals having to be observed.

3.N.4 Environmental impact on contents of cytostatical active compounds in mistletoe on scotch pine

Positioning: Applied

Short Description: This research is about the dependance of cytostatical compounds in european mistletoe on scotch pine on climate characteristics and N- and S-suplly. It can be studied by collecting mistletoe samples from scotch pine level 2-areas all over europe and analyzing the compounds in qustion as described elsewhere. Methods are standardized climate recording, RP-HPLC and ELISA. Samples are winter harvested mistletoe leaves and stems. Additional information are the level 2-climate recordings.

Justification: mistloetoe preparations are braodly administered to human cancer. However, preparations are not stable in terms of active substance content. Furthermore there is no knowledge on reasons for changing active substance contents. This research could provide a tool for selecting appropriate mistletoe specimen and thereby improving cancer therapy.

European relevance and collaboration: This issue is particularily suitable for collaborative European research activizies, because it connects data avvailable all over Europe. The Eidgenössische Forschungsanstalt für Wald, schnee und Landschaft can supply alpine mistletoe. Diverse european research instituts can supply additional level 2 climate recordings. The Frei Universität Witten-Herdecke can analyse the mistletoe samples. The key role is at the Forschungsanstalt für Waldökologie und Forstwirtschaft Rheinland-Pfalz.

3.N.5 Education for sustainable developement a new issue in the forestry professionalisation and in interdisciplinary cooperation

Positioning: Applied

Short Description: Die waldbezogenen Umweltbildung verzeichnet in deutschsprachigen Raum eine zunehmende Bedeutung bei steigender Nachfrage. Im Kontext der allgemeinen Entwicklungen in der Umweltbildung unter dem Leitbild der Bildung für nachhaltige Entwicklung gilt es auch für die Forstberufe Strategien zu entwickeln, dieses Leitbild in der Bildungsarbeit zu übersetzen und die Bildungsarbeit weiter zu professionalisieren. Ziel des Projektes ist es deshalb die europäischen Entwicklungen einer waldbezogenen Bildung für nachhaltige Entwicklung zu analysieren und sie für eine umfassende Qualitätsentwicklung und gendersensible Professionalisierung zu nutzen. Dabei ist insbesondere den Koopartionen und Networking-Prozessen mit den unterschiedlichen Akteuren/innen der Umweltbildung von Relevanz. Hierfür ist es notwenig, neben den begonnenen europäischen Initiativen der Waldpädagogik eine, eine qualitative Bestandsaufnahme der jeweils zentralen Akteure/innen, ihren qualifikatorischen Hintergruenden, den bestehenden Aus- und Weiterbildungsmöglichkeiten und den praktizierten Konzepten der waldbezogenen Umweltbildung zusammenzustellen und das Feld in der Dimension eines Teilarbeitsmarktes abzubilden. Wichtig sind hierzu neben den statistischen Quellen über Beschäftigungszahlen, einer Recherche der nationalen Organisations- und Angebotsformen waldbezogner Umweltbildung auch qualitative Untersuchungen in Form von Experten/innengesprächen und Interviews mit Akteuren/innen der unterschiedlichen Berufsgruppen im Feld der waldbezogenen Umweltbildung.

Justification: - Wissen über Arbeitsbedingungen und Strukturen des Teilarbeitsmarktes waldbezogener Umweltbildung unter dem Aspekt ihrer Existenzsicherungsmöglcihkeiten und hinsichtlich der Etablierung von "Gender"-Arbeitsmärkten - Überblick über unterschiedliche Organisationsformen der waldbezogenen Umweeltbildung und der Rolle des Forstwesens - Gesamtschau der waldbezogenen Bildungskonzepte und Ansätze als Bestandteile fortslicher und interdisziplinärer Umweltbildungsarbeit - Stand der europaweiten Professionalisierung der waldbezogenen Ansätze der Bildung für nachhaltige Entwicklung (BfnE) - Beitrag zur Qualitätsentwicklung und Professionalisierung forstlicher Bildungsarbeit im Kontext der BfnE - Weiterentwicklung gemeinsamer europaweiter Qualifizierungmöglichkeiten waldbezogner Umweltbildung

European relevance and collaboration: - Internationalisation in enviromental education in forests - possibilities for a hole european professionalisiation process in the education for sustainable development and forestry