



Tekes Boat-program

BETTER BOATS AND SERVICES

Overview to Research results

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Tampere 23.3.2011



Vene Tekes

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Development projects in the Boat-program

- Two different project types:
 - r&d projects driven by companies, results confidential
 - Research projects driven by research organisations, results public
- 30 different r&d-projects already started by companies, more to come
 - The size of the projects relatively small because of the SME-industry
- 22 different research projects have been started in the Boat-program, 8 of them now completed
 - See the main findings in the following slides.



Research projects in Boat-program; Business and services related

- VISION 2025: Services in the heart of the business development of boat branch. Helsinki School of Economics. Completed.
- VISION 2025 (II): Boat services in future. Aalto University and Turku University. 6/10 – 31.12.2011.
- VETOMO; Branch survey and a study for possibilities of modularisation. Åbo akademi and Vaasa University. Completed.
- Sustainable boating. VTT Technical Research Centre of Finland. Completed.
- FixBoat. Mikkeli and Kymenlaakso Univ. of Applied Sciences. 9/10 – 31.12.2011.



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Research projects in Boat-program; Design & product development related

- Open Wave, Open innovation in boat branch. Aalto University and VTT. 9/10 – 31.12.2011.
- TULVA, Boat branch of the future. Kymenlaakso Univ. of Applied Sciences. 4/08 – 30.4.2011.
- Better Products in time. Turku Univ. Of Applied Sciences, Univ. Art and Design, Vaasa University. 4/09 – 31.12.2011.
- HILVE, Quiet boats. VTT Technical Research Centre of Finland. Completed.
- Peräpeili; Transom forces in planing boats. VTT Technical Research centre of Finland. 9/09-30.6.2011.
- PROBOAT; Future concepts and materials in boatbuilding processes. Kokkola and Lahti Univ. Of Applied Sciences. Completed.



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Research projects in Boat-program Production and materials related

- ALVENE; Automatisation of welding of Aluminum boats. Lappeenranta University of Technology. Completed.
- MODUVA, Modularity as a tool for efficiency in boat manufacturing. Lappeenranta University of Technology 6/10 – 31.12.2011.
- LM-palkki; Structural design of FRP-stiffeners in series production. VTT Technical Research Centre of Finland. Completed.
- LiimaPalkki, Requirements and inspection methods for adhesively bonded FRP-stiffeners. VTT Technical Research centre of Finland 6/10 – 31.12.2011.
- VEKE; API and RTM in boat industry - developing productivity, surface quality and structures. Mikkeli University of Applied Sciences. 1/09 – 30.4.2011.
- WiND, Wireless sensor technology and NDT-methods in quality assurance of plastic composites. Tampere Univ. Tech. 9/10 – 31.12.2011.
- GreenLine 2012, Lappeenranta University of Technology. 7/09-31.12.2011.



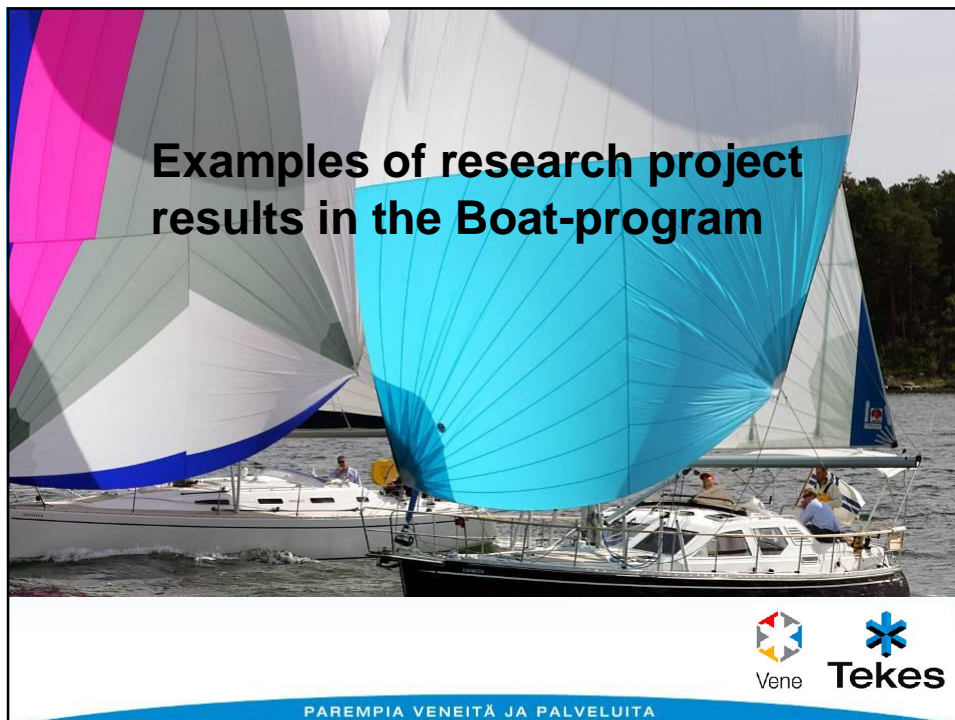
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Research projects in Boat-program; Devices and systems related

- iBoats; Smart boats, Metropolia University of Applied Sciences and Tampere Univ. Tech. 6/09-30.4.2011
- ePropulsion, Energy efficient propulsion. Metropolia University of Applied Sciences and Tampere Univ. Tech. 9/10 – 31.12.2011.
- Vene-ENE; New energy systems in boats. VTT Technical Research centre of Finland. Completed.
- Boat-MGT; Biofuel consuming micro gas turbine generator for yacht applications, Lappeenranta University of Technology. 6/09-30.9.2011.



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Vision 2025 – Services in the centre of the boating industry

- **The purpose of the study was to**
 - Identify the current demand for various boating-related services
 - Recognise consumer-profiles and
 - Identify bottlenecks in service-supply
- **Methods**
 - A **questionnaire** sent to boat owners and companies in the boating business (excl. manufacturing)
 - Clustering, Use Case-analysis
- **Results**
 - As presented in 2010: Three consumer types exist, one more is about to enter the market:
 - 1. “Do It Yourself”: Traditional Finnish type, avoids externalising anything, which can be done by oneself
 - 2. “Service-oriented”: More positive attitude towards more comprehensive services including upkeep. Young, urban.
 - 3. “Ageing yachtsmen”: Need more easing services in order to continue boating.



Vision 2025, Part II – The future of servitization in the boating industry 1(2)

- **The purpose of the study is to**
 - Demonstrate that there exists an unidentified demand of boating and related services by consumers (“non-boaters”) who hesitate entering into boating despite their interest. The reasons for hesitation may include image, social barriers or disparity between service expectations and current supply
 - Analyse the structure of this potential demand and service-expectations and preferences among non-boaters, who may enter the boating scene in the future



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Vision 2025, Part II – The future of servitization in the boating industry 2(2)

- The quantitative part of the study consists of
 - **a questionnaire** sent to consumers, who are not boaters, but who are interested in similar or substitutive free-time activities. Webropol based questionnaire to about 10.000 non-boaters.
 - Quantitative methods include explorative principal components analysis, K-means clustering, and non-parametric tests.
- The qualitative part of the study includes
 - **scanning potential services, which could be targeted to future boaters and current service-oriented boaters.**
 - random focus groups (students at the Helsinki School of Economics)
 - ethnographic observations in an environment where boating has a longer season than we and where the competition for boaters dollars and euros is very hard.



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VETOMO – Branch analysis and possibilities to modularisation 1(2)

What has been done in the research project?

- Entrepreneurs and organisations of the branch interviewed (about 50)
- Economic indicators reviewed
- Consumer query carried out
- Boat branch compared to other branches
- Finland compared to other countries

The research project started at 8/2008 and ended 5/2010

Project was carried out by University of Vaasa

The report "*Ui tai uppoa - Toimialatutkimus Suomen venealasta*"

Can be downloaded and printed at

<http://www.uvasa.fi/julkaisusarjat/luettelo/?julkaisu=610>



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VETOMO 2(2)

Summary of boat branch business and development :

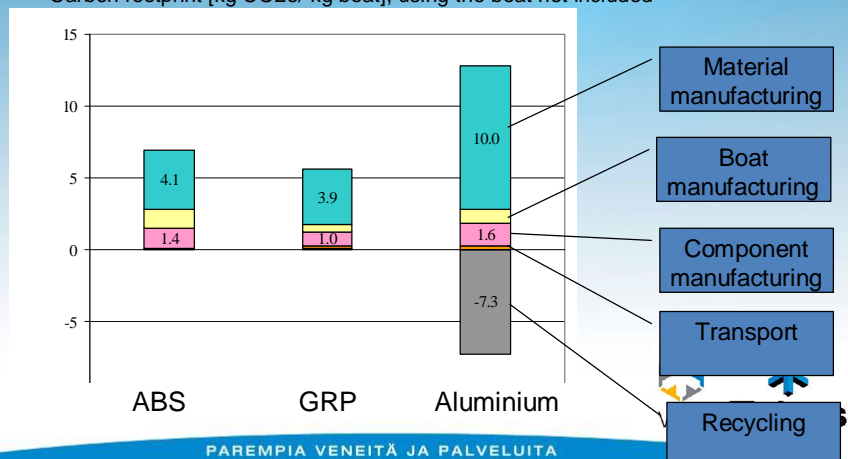
- Competition will be increasingly international, products and own resources shall be differentiated further
- New customer groups shall be sought and the extent of value added increased
- Contract out –model of manufacturing or international partnerships could open new possibilities
- The character of the product to be marketed is not fully understood; luxury is sold and produced like buckets
- Developing tourism and leisure activities, as well as services and marinas, could create a positive development spiral for boat branch
- Geparad strategies would be most suitable for the branch, lemming (sopuli) strategy works during upturn period, crucian carp (ruutana) strategy could be most realistic and sustainable.



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Sustainable boating

- Life cycle environmental impact was calculated using carbon footprint and Eco indicator 99 –ecopoints for a group of powerboats
- Main findings:
 - Environmental declarations regarded as the best way to go forward
 - Figure: Examples of Indicative environmental impacts of outboard motor boats Carbon footprint [kg CO₂e/ kg boat], using the boat not included



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FixBoat

Diagnostics and Repair of Composite Boats

1.9.2010-31.12.2012

- Kymenlaakso and Mikkeli Universities of Applied sciences
+ 12 Companies (boat yards, insurance companies and material suppliers)
- Composite structures in boats become more complicated and harder to repair
- New materials and repair methods need to be tested and developed
- There is a need for NDT and quality assurance methods in boat repair
- Current status:
 - Repair and surveillance methods used by partner companies are studied
 - Available NDT methods are studied
 - Test plan and preliminary tests of the adhesive properties of the repair resins has been done
 - Comparative tests of materials, repair methods and NDT are to be completed



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Open Wave – Open Innovation for Future Boat Industry (August 2010 - June 2012)

MUOVA and VTT with six companies



Target

- to identify product and service possibilities in boat industry through open innovation methods

Main research questions

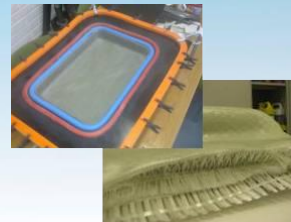
- What kind of role does user and trend information have in the development of future products and services for the boat industry?
- How does the concept generation method function in identifying product and service possibilities?
- What kind of boating products and services could increase boating?
- What kind of technological trends create new product and service possibilities in the boat industry?



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TULVA – The Boat Industry of the Future

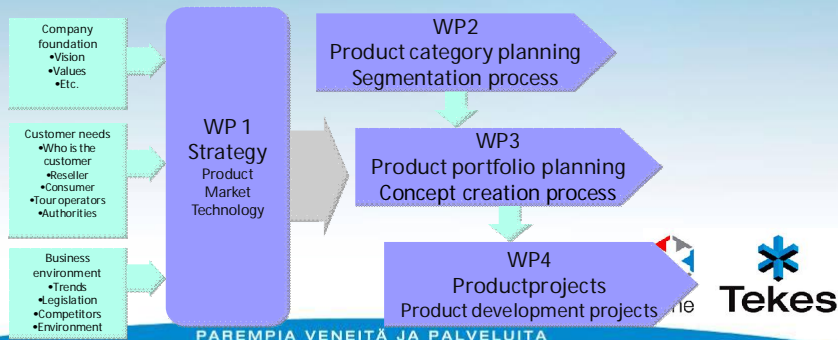
- Kymenlaakso University of Applied Sciences and seven companies
- Four main research areas: sense ergonomic, conceptual design of boats and boating, production techniques for composite materials
 - Sense ergonomics: notice all senses, minimize stress, maximize safety, better feeling, and so on.
 - Three concept of boating and boats, two concepts for day cruising and a concept for live aboard
 - Conceptual designs for companies needs
 - Composite materials and production design experiments



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Better Products in time

- Turku University of Applied Sciences
 - Coordination of research made in 3 research institutes (Western Finland Design Centre MUOVA, University of Vaasa and TUAS)
 - TUAS responsible for WP1, WP4 and WP6
- MUOVA responsible for WP2 and WP3
- University of Vaasa responsible for WP5 (Production visioning)
- Key findings, entire process
 - Significant potential to improve the product process of Finnish boat industry by implementing a systematic framework for new product development
 - More strategy impact on product process needed



BPIT/ WAVE-project

Aalto University School of Art and Design | University of Vaasa | Western Finland Design Centre MUOVA

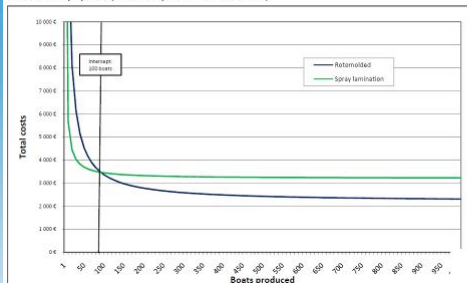
- **Method** to develop radically new product and service concepts based on social trends and user information in recreational boating industry was developed and modeled
- **Trends** in leisure time and consumer behavior influencing recreational boating were identified
- **Segments** among Finnish recreational motor boaters were identified
- **Drivers** for product and service development in recreational boating industry were envisioned
- **Product and Service Visions** indicating trends in leisure time and consumer behavior were conceptualized
- Concept of a boat platform for lean production, *The Production Vision* was developed in association with Vaasa University
- **Handbook** illustrating findings of the project will be published



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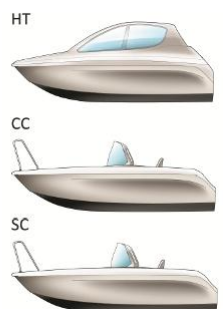
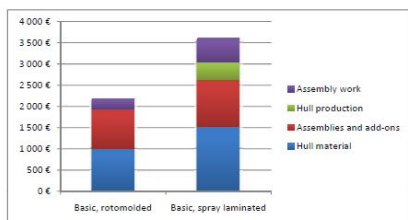
Production platform

Investment payback (machinery + molds investment)



- University of Vaasa team analysed potential of production platform developed by MUOVA.
- Findings:
 - Design for assembly can reduce installation time
 - Significant cost reductions can be achieved by increasing component commonality

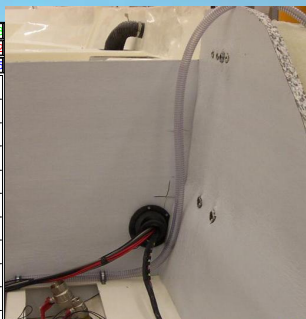
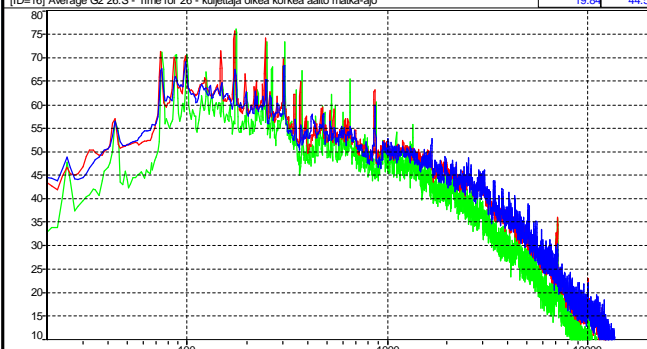
Production costs



HILVE – Quiet boats

- VTT and Kuopio university, with 5 companies
- The goal was to develop boats with more silent driver's cabin and with a pleasant sound environment. The focus of the project was in 6–14 m boats with a closed cabin and stern drive engines.
- Main findings:
 - With (quite) quick measures a 4-5 dB(A) reduction was attained
 - Vibrations via transom are difficult to cope with

[ID=10] Average G2 26:S - Time for 26 - kusi o tyyni matka-ajo	19.84	32.3
[ID=7] Average G2 26:S - Time for 26 - kuljettaja oikea keskiaalto matka-ajo	19.84	43.2
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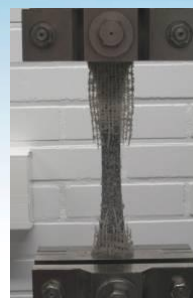
Peräpeili: Outboard Engines forces on the Transom

- VTT Technical Research Centre of Finland with 4 companies
- Aim
 - To create a method for approximating the forces on the transom
- Why
 - The scantling standards do not give any design forces for transom design
- How:
 - A 3D bracket scale was created to measure the forces
 - Accelerations measurement on boat
 - Forces between outboard engine and forces
- Main findings (temporary):
 - Large accelerations and forces also backwards when jumping
 - Large forces when boat slowing down in waves also without jumping due to mass movements
 - Propeller was not “kicking” during jumps when hitting the water but was cavitating and caused backwards forces by slowing the boat down.
 - The forces are as expected relative to the measured accelerations
- Still to do
 - One boat with large engine to be measured
 - Further analysis and creation of approximation method



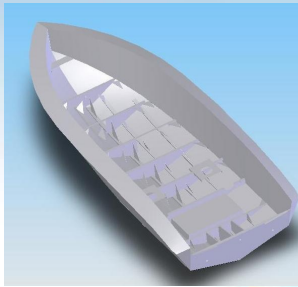
PROBOAT – Searching new materials and concepts in boat interiors

- Keski-Pohjanmaa and Lahti universities for applied sciences, with 6 companies
- The goal was to develop new, open-minded concepts with new materials for boat branch
- Different sub-projects, f.ex. A study of the environmental load of different textile materials
- More results at <http://www.proboat.org/>



ALVENE: Automated welding of aluminium boats

- Lappeenranta technical university with 5 companies
- During 1990's robotisation of welding of Al-boats was tested, but the technology was then not sophisticated enough.
- Main findings:
 - The dimensions of the part changes during welding due to shrinkage and thermal expansion. Accurate gauges are needed to follow these changes during the manufacturing process.
 - The welding time can be shortened significantly (>50%) by automatisation, but new arrangements in production are needed to fully exploit it.
 - If the fitting tolerance is more than 1,0 mm, robotisation cannot be utilised.



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MODUVA: Modularity as a tool for efficiency in boat manufacturing

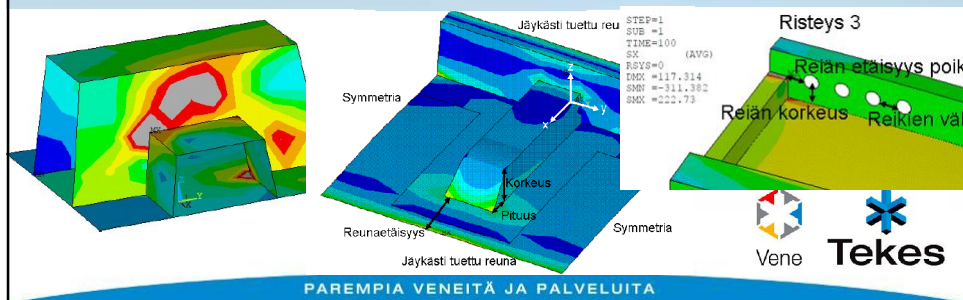
- LUT with 4 companies
- Findings in previous ALVENE-project are to be taken into account and technical solutions developed
 - Modularity of base frame of aluminum boats should be increased
 - Subassemblies for welding
 - Same modules for several boat models
 - Modular fixturing in robotic welding
 - Good accessibility for the robot
 - Short set up time for next model
 - Minimization of distortions in welding
 - Welding sequence and procedure optimization



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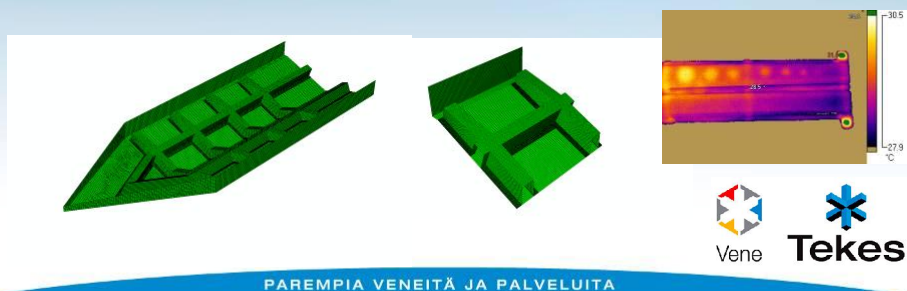
Structural design of FRP-stiffeners in series production

- VTT with 3 companies
- Scantling determination of stiffeners is usually ok in the middle part of the beam, but details like crossings, holes or beam ends are more demanding.
- In series production, the solutions are often structurally non-optimal
- Main findings:
 - Discontinuity of the stiffeners in crossings leads to high stress concentrations if the height ratio is >0.5 ; especially ratios around 0.9 shall be avoided
 - If a stiffener is ending at a panel, the distance between the edge of the panel and stiffener end shall be $> 0.5 h$
 - The diameter of possible holes in the crossing area shall not exceed $0.4 h$



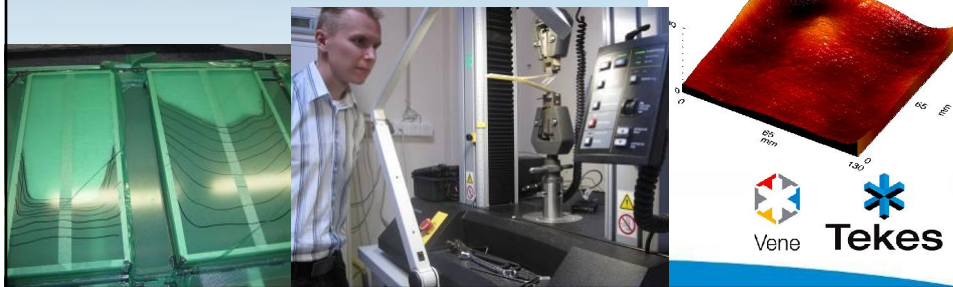
Requirements and inspection methods of adhesively bonded stiffeners

- VTT and VTT Expert Services Ltd with 5 companies
- The aim for the study is to find out the factors degrading the stiffener bond, determine the suitable analysis and design methods, and to find out the critical manufacturing related defects.
 - Numerical finite element analyses and experimental tests are utilized in the project
 - Feasible inspection methods are developed for the boat building industry
 - Improvements in the manufacturing practice are also considered



Boat industry manufacturing technologies: improving cost efficiency, surface quality and structures (acronym VEKE)

- Tampere University of Technology, Mikkeli University of Applied Sciences and 6 Companies
- Main actions:
 - Several RTM-processing simulation programs were compared and PAM-RTM was tested in practice.
 - The damage tolerance of infused laminates depending on resin type, reinforcement type and stacking order choises has been studied in co-operation with Ifremer research institute from France.
 - Different mould materials and the resulting product properties have been studied
 - Reinforcement kit cutting, packing and transporting has been studied both from technological and economical point of view.
 - Literature survey and physical tests to obtain better laminate surface quality has been performed
 - Master's Thesis "Vacuum Infusion and Resin Transfer Molding in Manufacturing Boat Laminates - A Technical and Economic Study" has been finished. Manufacturing costs for the studied methods are practically equal.
- In process
 - Futher laminate surface quality tests are being performed.



WiND

- Research Project -

**Langaton anturitekniikka ja NDT-menetelmät
muovikomposiittien laadunvarmistuksessa**

**Wireless sensor technology and NDT-methods in plastic
composites quality assurance**

- The key idea in the WiND-project is to study, which new technologies and methods can be used to develop quality assurance and control in the composite industry.
- Tampere University of Technology (TUT) / Department of Materials Science, Plastic and Elastomer Technology/ Kokkola lead by prof. Pentti Järvelä ja prof. Jyrki Vuorinen
 - -composite materials and their testing
- University of Jyväskylä/Kokkola University Consortium Chydenius (KYC) / ICT-reseach team lead by prof. Ismo Hakala
 - -wireless sensor technology and industrial applications



WIND

Aims, done so far, coming up

- Aims in the field of composite quality assurance are to introduce the new and the most user-friendly methods/devices for the quality control during the production, after the production and also for the damage detection.
- Aims in the field of wireless sensor technology are to find out how to monitor and follow the environmental status in production, and follow the parameters affecting to the performance of the production tools or to follow the status of composite structures in use.
- The aim is to find new ideas when combining the traditional NDT of composites with the wireless sensor technology.
- Project started in November 2010. The research ideas so far prioritized and developed further with the participating companies (Baltic Yachts, Mervento, Finnmarin, Exel Composites, Terpol). A diploma work for M.Sc. tech. (TUT) started 1.3.2011.
- Coming up: Experimental testing starting in may 2011. Device/method-workshop (early summer -11) and research seminar (late -11). Project ends 30.4.2012.



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Greenline 2012

- Lappeenranta University of Technology with 5 companies
- main aim to study biocomposites in marine applications
- main results until
 - usable in different applications especially as hybrid composites
 - welding/gluing possible
 - very first prototype for experiments, "welded wooden boat"



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Intelligent Boats 2009...2011



The project concentrates on the boat standards, network, electronic and the software. The system modularity, availability and usability has an important role in this project.

Main findings:

- NMEA is the most important **information network** in the next generation boats
- The control of actuators are made for example with CANopen
- Actuator and sensor networking is reality when building quality boats



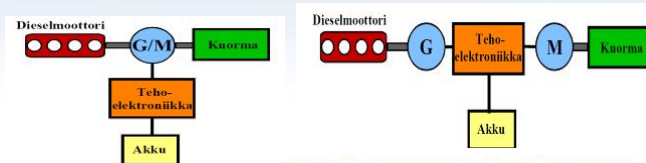
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ePropulsion

The project concentrates to efficiency of electrical drive lines and the energy using in the boats:

Main findings:

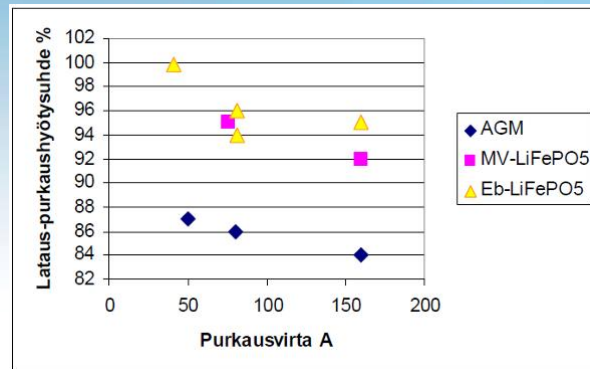
- The electric motor is suitable for example to water-jets
- The efficiency of drive lines is the key factor in building good systems
- The efficiency and solar cells enables to build autonomous boats
- The simulation helps to build efficient systems
- The one kW in an electrical motor is the same as three hp in a combustion engine



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Vene-Ene – New energy systems in boats

- VTT and Vaasa university for applied sciences with 4 companies
- An overview of different technologies to produce electric power using renewable sources in boats.
- Main findings:
 - Measurements of the charge-discharge-efficiency of two different Lithium batteries and an AGM-battery show the clear advantage of the Li-batteries



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BOAT-GT: Liquefied biofuel fired micro gas turbine for boats

- Lappeenranta technical University with Aalto University and 3 companies: T-turbine, Axco-motors, Pauniahon veistämö
- To develop a light, Brayton cycle based power generator for boats, which can be run with liquid biofuel.
- Main findings:
 - Original idea to use pulse type compression is not meeting the requirements.
 - Research is now concentrated on building of a 6 kW_e micro gas turbine aggregate, based on existing gas generator and a power turbine PM generator design developed in this project.
 - This aggregate, producing 6200 W three-phase current is, if compared to the power, extremely small and light (only c. 15 kg; normally piston engine based aggregates weight with similar output over 100 kg). Prototype is expected to be ready for testing in the beginning of September 2011. Drawback of this easy-to-carry power pack is rather low fuel efficiency.



Testing assembly of the gas generator



Simulated picture of the 6200 W aggregate in real size

PS

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Applying the results

- The research results are mainly public
- The contact persons can be found on the annual report as well as at the website (www.tekes.fi/vene → projects)
- The main findings will be gathered to a summary report in the beginning of 2012
- The results of the company projects are confidential, but will also spread to the boat branch as new products and services are launched



Summary

Tekes, the Finnish Funding Agency for Technology and Innovation provides incentives for companies to develop their business and apply the best available expertise. The result of the Boat-programme is better boats and services for the consumer. These are provided by profitable and competitive Finnish businesses.

The Boat-programme was started in a totally different market situation than we now live in. Boat branch in Finland have however been eager to develop their products and services during the recession. Tekes Boat-programme has offered financing and a cooperation forum for this.

Contacts:

www.tekes.fi/vene

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