EUROPEAN BOAT DESIGN INNOVATION PLATFORM – LEARNING FROM THE AUTOMTIVE INDUSTRY

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SUMMARY

Design and manufacturing innovations are the keys to maintaining the competitiveness of the European boat industry in world markets. There are many similarities between the small boat and motor car design and manufacturing practices. While the automotive industry invests billions in R&D, the marine industry has been unable to match anything near the investment by the automotive industry. The sophistication of design and production practices in the marine industry has not been to the levels noted in the automotive industry.

This paper reviews the work of the European Boat Design Innovation Group (EBDIG) which aims to make the European Boat Design Industry more competitive in the international market place by providing on-line training material for designers working within the industry. The review summarises the results of several evaluations and what and how advanced manufacturing and design methodologies and technologies from the automotive sector can be transferred into the marine sector to facilitate design innovation and competitive advantage.

Keywords: Boat Design, Boat Design Skills, Transfer of Technology from Automotive to Boat Design

1. INTRODUCTION

In the first EBDIG paper [1] details of the EBDIG project were presented and the outcomes of the first EBDIG questionnaire were discussed. The research carried out prior and as part of the EBDIG project clearly shows that competitiveness of European boat industry rests with the innovation in design and manufacturing [1] [2].

While the first paper focused on what and how innovations in automotive industry can be transferred to boat design and production practices, this paper concentrates on the state of boat industry and targets the most important areas for consideration.

Since this paper is written independent of the first paper [1] it worth re-stating the main purpose of the European Boat Design Innovation Group (EBDIG) which was formed and funded by the EU to make the European Boat Design Industry more competitive in the international market place by providing on-line training material for designers working within the industry. The objective of EBDIG is to transfer advanced manufacturing and design methodologies and technologies from the automotive sector into the marine sector to facilitate design innovation and competitive advantage.

This Leonardo funded project concerns primarily developing innovative learning materials for designers working within the Marine industry. The Group intends to achieve this by transferring embedded practices within the automotive industry through courses in: design visualisation, ergonomics and telematics, and sustainable materials. Delivered by an interactive web-based Digital Innovation Studio

Considering that the European boat industry is worth over 24 billion EUR and maritime transport represents 40% of internal EU transport and carries 90% of goods imported or exported by the European Union and the competition from the East and North America for larger share of this market, this research is both necessary and timely [2]. The formation of a group of well-known boat designers, education and quality specialists to learn from the R&D in the automotive industry and exploit the opportunities through the transfer of innovations from automotive design and manufacturing techniques to boat design and production in itself is novel. This is not to say that the automotive industry does need to learn from innovations in boat design and manufacturing processes but the focus here is to safeguard the future of the European boat industry through innovative research.

This paper offers three major topic areas for in-depth consideration, viz.,

- Sustainability
- Comfort
- Safety
- Telematics

The topics above are intended to make European boat producers more agile, cost efficient and responsive to market demands. The paper makes a contribution to the efforts by the industry to respond to their competitors and customers by demonstrating their efforts to built-in sustainability of materials used in the whole product through the application of exciting innovative practices and to be able to remain competitive by being proactive, or at least by learning to react quickly to changing consumer preferences. Issues relating to comfort have been a main area of research and it seems it has a high priority for customers of boat industry both in terms of buyers of products and users of products and services.

As far as safety is concerned somehow the users and buyers of boats do not concern themselves with related issues and make the assumption that safety issues are taken into considerations by third parties. Early research showed that Safety is of a lesser concern to users and buyers of marine products such as boats while of utmost importance to producers of these products and services. Here perception of users and buyers has to change. Safety must been seen as crucial and its importance fully understood. Neglecting safety could have huge legal implications and lead to unnecessary costs. Aspects relating to safety will be referred to later the main body of the paper.

Telematics, similar to sustainability, is a new discipline and judging by the responses to the EBDIG second questionnaire is not seen as significant but a review of the research findings, presented later in this paper clearly indicates that it has far reaching consequences. The emergence of first Japanese cars, offering a range of gadgets as standard, in European markets is to be studied carefully [3] it could be realised that telematics could provide a competitive edge.

The sophistication and design and production practices in the marine industry has not been as wide spread and to the levels noted in the automotive industry. A few marine companies are starting to change this, however much more needs to be done to provide the skills to meet the increasing power and demands of the consumer in a globalised market.

The research into sustainable materials and use of sophisticated telematics in boat design and manufacture are still in embryonic stages while the opposite is true for the automotive sector where vehicle telematics, ergonomics, high level visualisation representation and sustainable materials and fuels are common place.

2. TRANSFER OF INNOVATION

According to a recent report [4], "the European industry is losing competitiveness as challenges from lower-cost economies have increased their share of world marine markets". For instance, Korea made shipbuilding a strategic industry in the 1970's and become the top ship builder in the world.

China is now following Japan and Korea, and has plans to become the world's largest shipbuilding nation by 2015 and command 35% of the global order-book" [5]. A European solution is required to safeguard boat design and production industry future and maintain competitiveness. Since the West cannot compete on labour price it is even more important that it concentrates efforts on creativity and innovation [6]. EBDIG learning material is being finalised to provide training and an infrastructure to empower employees of European companies to operate more innovatively and efficiently and keep the cost to its bare minimum.

3. TARGET GROUPS

The EBDIG project is aimed towards employees and managers working in the marine industry targeting those who are 40+ as well as the industrial design professionals looking to work in marine industry. As part of their training they will produce an E-portfolio, which may be accessed by any individual or organisation that are provided with the password. There is no reason as to why the material should not be incorporated in the curricula of boat design at undergraduate level. Furthermore, in an earlier brain storming session of some 20 top boat designers and manufacturers and the results from the development and delivery of an e-learning course designed through support from one of the EBDIG partners (www.egmdss.com) it was clear that e-learning is attractive to the target groups which often do not have time to attend classes in a college and would prefer to learn from a distance. The hours devoted to training, when learning remotely, could also be varied depending on the designers need.

4. DESIGN CONSIDERATIONS

This project is primarily about transfer of innovation in design practice from the automotive sector to small craft industry in Europe and ultimately about identifying, and when required, design skills for modern designers of boats and small crafts.

The contemporary designers are now expected to be part Engineer and part artist; sociologist, psychologist and a marketer; part everything and part nothing a statement made in the EBDIG Paris meeting in Paris [1]. Design cannot be considered without a good understanding of manufacturing methods and practices and a real appreciation of quality. Either the designer should have this knowledge or s/he should have access to good production engineers and quality specialists.

The term design explains how ideas turn into real objects. Design in automotive terms is a discipline in itself. The automotive design, like any other form of design process, starts with the idea in the designers mind. It is then presented in written form, and at a later stage it is visualized and often sketched. These presentations or sketches, with a given standard, with rules and definitions, are then transformed generally into a set of technical drawings. Today, with modern technology these drawings are conceptualised and computerised hence the terms such as computer aided design (CAD) and so forth [7].

The computerisation has also helped to store and access information quickly and provides almost unlimited storage for information. These computer aided systems gradually became more integrated, for instance, combining design and manufacturing processes and other activities like cost became the standard. Once an idea is

transformed into a set of technical drawings the whole process of manufacturing it and related procedures such as costing, testing and marketing it, up to recently, was part of what is known as computer integrated manufacturing (CIM) systems. CIMS provided easily accessible, consistent and secure data [3]; [8]. CIM also provided the integration of analysis, synthesis, simulation, modelling to go hand-in-hand with the evaluation and verification process in an interactive and iterative manner.

CIMs permit a project team to work together allowing information like finance and marketing to be added to design and manufacturing more effectively. These systems allow the information coming in and going out to be controlled according to the given standards. In recent years, Integrated Business Information Systems often referred to as IBIS have taken the place of CIMs [3]; [9]; [10]. These systems allow automation of repetitive tasks and allow information to be accessed and controlled intelligently, enabling the designer to be more creative who brings improved quality and cost effectiveness.

Even with all technological developments the main stages of design cannot be computerized. An idea still needs to emerge, visualize or sketched and later detailed specifications are required which can only be generated through the human mind. In recent years there has been some attempts to develop an artificial brain primarily as a decision making aid to the human mind [11] and to establish relationships among various sets of data which may not be related in conventional sense. The application of the artificial brain reduced the cost of designing boats by some 50% [12]; [13]. The review of papers arguing for application of more intelligence in design [13]; [14]; [15] clearly shows the advantages. Data mining and extracting has also become highly automated in search for information in the market [16]; [17]; [18]. and in demand and sales forecasting. Forecasting tools are being used to decide which product to design and/or make based on market demands [15].

There are six generic design stages [10] which were considered by EBDIG. An earlier paper on EBDIG [1] gave detailed account of the design stages and processes. Several industry reports and papers ([4]; [6] [16]; [19]; [20]; [21]; [22]; [23]) provided a whole range of sources on good practices in design, manufacturing and quality relating to automotive industry. The paper by [12] gave some indication of how building intelligence into design processes including costing practice could reduce cost of designing boats substantially.

A paper by [14] refers to the recent emergence of Market Driven Design and Manufacturing practice which not only integrates various activities such as design, material selection, production, finance, sales and marketing [16]; [17]; [18]; but has identified a requirement for intelligent assessment of the market for a given product as a basis for considering its design and production techniques. The Market Driven Design and Manufacturing promotes the concept of problem definition and market assessment for a product as part of the idea generation and creative idea evaluation followed by further assessment of the idea and its presentation as a basis for finding a feasible solution to a problem. This process is a prelude to the conventional design viz., design specification, concept design, material and method selection leading to detailed design and its presentation and in parallel focusing on manufacturing methods and evaluation and verification. In automotive design the verification is always preceded by measurement and conformance to design parameters and product intended features as well as the manufacturing specifications.

5. QUALITY DIMENSIONS

In the first paper it was highlighted that the aspects of design relating to the Quality Dimension have often been neglected. Quality has also a qualitative dimension besides its quantitative dimension like specifications and performance ratios. Generally the customers appreciate the quality of a product or service according to these dimensions [24] worked on the factors needed for a product or service of high quality and classified eight dimensions of quality:

- Performance
- Features
- Reliability
- Conformance
- Durability
- Serviceability
- Aesthetics
- Perceived quality

The meanings of above are self-explanatory and a summary in what they mean in practical sense are given in [1].

6. QUALITY CHARACTERISTICS

Many designers are often familiar with the need to make the quality measurable and demonstrable and that quality characteristics should be technically grouped. At this point, customer or the consumer is to declare her/his expectations and the producer is to ensure quality. After all, quality is formed by the intersection of the criteria by both parties (namely the customer and the producer) as noted by [14].

A customer who is satisfied is the one who obtained the expected quality. Otherwise, s/he loses her/his trust in the producer's quality, and product responsibility is reviewed again. The success of many companies today is based on delighting the customer with added perceived values not expected by the customer when the order was place or product purchased [26].

Gitlow and Gitlow [27] offered three basic quality types to produce a qualitative product or service. These are: Design Quality, Quality of Suitability and Performance Quality. Design Quality or quality of design comprises even the most trivial conditions of a service or product to meet the needs of the customer. This means that the product or service has to be designed so that it can also meet even the insignificant wishes of the customer. Quality of design begins with market demand survey and sale and continues with determining a concept of quality of a product or service. Then, specifications are prepared for the concept of a product or service.

From the arguments put forward by [27], it seems that market demand survey, what considered important then, has not been taken seriously by many companies today and the design and production philosophy has been to some extent still based more on 'push' systems than 'pull' hence they must have ignored the suggestion made by scholars such as [27].

Today sophisticated online tools exist to search for data available online ([18]; [11) and concept of world-class manufacturing [22] and Quality Control improvement approaches [28] are applied in design and production planning in the manufacturing industry in general and should be encouraged for adaptation in small craft design building practices.

There is however, an important warning [26] and that is, "you cannot just go on satisfying all the customers all the time". This is neither practical nor feasible. A new concept introduced in Factories of the Future projects was the design of grade. Gozacan and Ziarati [26] suggests that before the design process commences the grade of product needs to be specified viz., is a product for use by masses or a select few? Is a Ferrari being designed or a Mini? Is it 2 Star hotel or a four star hotel? Is it a degree programme or a foundation degree/HND? The second issue is the need to rank the dimensions of quality as proposed by Garwin [24] for a given product. Does perfromace have a higher priority than reliability? Gozacan and Ziarati [26] are adamant that the dimensions of quality should be quantified for a product and specified before the design process is even started. He also argues that only companies who work on the 'Pull' philosophy will be able to remain competitive i.e. those that find out what the customer wants first. He does not reject the concept of 'push' system as he notes that for new products and services to emerge a push system may even be more important than a pull system.

7. DESIGN SKILLS QUESTIONS

EBDIG project primarily developed three questionnaires. The first developed by TUDEV (Turkish Partner in the project consortium) focussed on what and how design and manufacturing practices which are considered innovative can be transferred from automotive sectors to boat industry. The results of this questionnaire were published [1] in the HPAS conference in 2010.

The second questionnaire designed by Ladida Design relates to the design skills the boat designers should possess. The draft questionnaire was presented to a sample of the target groups viz., boat designers and producers. It contains several design skills which required the responders to choose from three options to state that skill was 'very useful', 'useful' or 'unhelpful'. The group almost collectively found the following skills very useful:

- Conceptual Thinking,
- Design Concept Generation,
- Ergonomics,
- 3-D Modelling particularly Digital Modelling and Animation,
- Aesthetics specifically option of colour combinations for texture,
- Use of Materials and Trends
- Manufacturing Processes,
- Sculptural Modelling,
- Surface Treatment, and
- Human Factors

were noted to be useful skills.

When asked about regulatory knowledge while they all considered them to be important many were unaware of the regulatory standards applied to boat design and manufacturing of products. There were aware that interior design and lighting are crucial and sophisticated CAD techniques (use of Catia, for instance) are a must for any designer. Although not a major issue in automotive design the water system on board of the small craft noted to have a special place in the heart of the boat designers.

Majority of designers made very little comment on the importance of sustainability and telematics other than stating that gadgets and sophisticated navigation equipment are becoming important features of a designer's work.

Many were of the view that marketing should be directly linked to the design process and use of software to assess ergonomic evaluations is becoming common place. Majority did not mention R&D but a few were keen to find out more about funding and how joint research could be initiated. The need to asses the future demand was also mentioned but not to the extent of the work being carried out by researchers such as [17]; [18]; [25] for instance who are applying sophisticated Artificial Intelligence techniques in design process and future trends for vessel of all kinds and sizes. The former introduces costing issues and the latter how 'pull' approaches could be established by the ship and boat designers and producers.

When asked about a question posed in an earlier evaluation [1] viz., what are the two most important considerations regarding the following list?

- Looks
- Performance
- Quality, luxury, comfort, use of space etc.
- Materials both external and internal
- Features
- Cost
- Telematics
- Sustainability
- Automation - Level of sophistication,
- Safety features

the top requirement was quality expressed interestingly again in terms of luxury, comfort and use of space followed by performance and level of automation. Safety features were acknowledged of being significant as well as reliability. Cost was again an issue particularly for smaller boats. Terms such as sustainability and telematics were not considered as important to buyers of boats. However, when telematics was considered as control and automation devices and communication systems, as was the case in the first questionnaire (evaluation), it was thought to be important. The reliability, as was the case before, was an issue and based on the discussions that took place it was agreed that there is a connection between reliability and safety. Majority of the participant had come from either automotive sector or studied (or were) naval architecture(s). There was one who was previously a product designer and several of those who participated in the survey knew of sub-contractors working on the propulsion and navigation systems

8. THE NEW QUESTIONNAIRE

The new questionnaire was designed by the EBDIG Group as whole. Table 1 shows the summary of the questions and responses. What was interesting was that when the questionnaire was used in group seminars with groups or individual designers the outcome was highly interesting. Table 2 shows the innovation practices/products that can or should be transferred to boat industry. The initial table was prepared by Ladida Design and discussed in the project partners meeting in Paris in May 2010. The table quite clearly shows the areas that partners and main actors in automotive and boat design and production industries consider worthy for further consideration. On this basis the table 2 was presented to the participants at special seminar, composed of leading boat designers and producers, organised by TUDEV, and those that could not attend where contacted through teleconferencing or met at an earlier or later date. The items written in Italics (blue colour in the table) are those which were added during the seminar.

9. CONCLUSIONS

The conclusions reached in the first EBDIG paper [1] still are valid. There was a consensus that design and innovation go hand-in-hand and they are the key processes for successful products. As stated in the first paper a great many people buy a car for a good reason viz., its reliability, looks and so forth. In the same way a particular type or model of boat seems to sell more because of its particular design feature(s) or other quality dimensions. Being competitive means a designer/design team and/or a boat producer has to be aware of customer needs and have knowledge of the market trends. To ‘surpete’ [3] one has to go beyond the normal norms of competition and the existing means of satisfying ones’ customers but to delight the customer with special or new features or capabilities. The boating industry must respond faster and more effectively to changing requirements which now includes tighter legislations on materials used and engine emissions, for instance. The opportunity to transfer designs and innovations as demonstrated in the first EBDIG paper and those shown in table 2 would help the industry and individual to continue having access where some of the current ideas and products and processes could be adopted/adapted from other sectors/industries particularly from the automotive industry which is the main aim of EBDIG.

The ideas are expected to result in optimised methodologies and/or materials which are expected to lead to enhance products or services. The second questionnaire designed to seek the views of people in the automotive industry as well as those in the boat design and building community to identify what and how innovations from automotive industry can been transferred to boat industry was thought to be a good means of getting information to obtain useful responses to many questions raised. The seminar composed of boat and automotive designers and producers after the reviewing the outcome of the first questionnaire was also a good means of generating ideas and practices which can now be seriously considered by boat designers. The third questionnaire developed by Ladida Design to identify the skill needs of future boat designers will help to develop the content of the intended EBDIG course to satisfy the future requirements and assist existing and future designers to respond to new ideas presented in table 2.

In summary EBDIG is about making the yachting sector in particular to become more competitive through rapid learning, benchmarking and rapid prototyping of the appropriate innovative practices in the automotive sector. The process created by EBDIG platform is expected to continue seeking innovations from other sectors. The first and second questionnaires are expected to be reviewed and amended with a view to seek more feedback. EBDIG will make the European boat industry stronger and more resilient in the future.

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Table 1 – Summary of responses to EBDIG First Questionnaire

EBDIG Questionnaire													
Results													
1	2	3	4	5	6	7	8	9	10	11	12	13	Other Country
Country	Type	Sector	No of Designers	No NAs	No Designs/Vessels	% Designs	Quick Visuals	Ergonomics	Speeding Des Cyc	Comptetive	Sustainability	Telematics	
Germany	Manu	S Sp Boat	1	0	3	7	Yes	Not Sure	Yes	Yes	Yes	Not Sure	Germany
France 1	Design	RIB	1	0	20-30 Des & 200-300 Ves	10	Yes	Yes	Yes	Yes	Yes	Yes	Africa
France2	Design	Sp & all large	2	1	5-10 des	-	Yes	Yes	Yes	Yes	Yes	Not Sure	Italy
France3?	Design	S Sp Both	2	2	3	-	Yes	Not Sure	Yes	Not Sure	No	Not Sure	US, UK & Swe
Italy1	Manu	Sup Yat	11-15Des	2	1	5	Yes	Yes	No	Yes	Not Sure	Not Sure	Germany
Italy2	Manu	Mot & large Yat	11-15Des	11-15Des	Over 200	10	Yes	Yes	Yes	Yes	No	Yes	Many (TR)
Italy3	Design	Mega Yat	5	4	3	4	Yes	Yes	Yes	Not Sure	Not Sure	Not Sure	Several
Italy4	Design	Sup Yat	3	2	3	4	Yes	Yes	Yes	No	No	Not Sure	Several/Many
Italy5	Manu	Sup/Mega Yat	11-15Des	6-10NAs	2	4-6%	Yes	Yes	Yes	Yes	Yes	No	Many (TR)
TR1	Manu	S. Sp	2	1	5-10Des	10	Yes	Yes	Yes	Not Sure	Not Sure	Not Sure	TR
TR2	Manu	Mot	2	1	2	-	Yes	Yes	Yes	Not Sure	Not Sure	Not Sure	TR (NL)
TR3	Design	Mot/Sup	2	1	2	7	Yes	Yes	Yes	yes	No	Yes	TR
TR4	Design	Sup	2	1	1	10	Yes	Yes	Yes	yes	No	Yes	Italy

Important findings:

- **Responses included a mixture of design and manufacturing companies.**
- **There were responses from a whole range of small craft designers and Manufacturers.**
- **All design and manufacturing company who responded employ boat designers as well as at least on Naval Architecture.**

Summary Overall response to Questions 8-13 – Questions shortened for this summary:
Questions 1-7 Generic questions

Questions 8-13:

8. Would the ability to quickly visualise design concepts enhance your design process and marketing activities? **Yes**
9. Do you think the ability to incorporate ergonomics effectively in the design would improve your company's reputation for quality? **Yes**
10. Would reducing the design cycle (time & cost) give you opportunity to develop more new models? **Yes**
11. Would this give you a competitive advantage in the market place? **Yes**
12. Would implementing sustainability in your design or manufacturing process increase your market share? **Yes/Not Sure/No**
13. Would the enhanced user experience of Telematics technology be beneficial? **Not Sure/Yes/No**

Table 2 Practices/Products for transfer from Automotive to Boat Industry

Automotive	**Marine**
End of life strategy, design for disassembly	End of life strategy by builders, design of boats for disassembly
Use of sophisticated CAD/CAM systems	
Commonality of components used (GT)	*Use of GT in Boat Design and modularisation of interior design*
Fatigue and endurance testing	Fatigue and endurance testing
Product lifecycle management	Product lifecycle management for yachts
Diesel Particulate Filter	Marine Diesel Particulate Filter
Use of Hybrid system	*Hybrid engines for boat propulsion*
Alternative energy/engine systems	Alternative propulsion systems
Aerodynamics to reduce drag	Aerodynamic testing on the superstructure, decks
Styling and functionality for efficiency	*Styling and functionality for greater efficiency*
Rain/spray detection for automatic windscreen wiping	Rain/spray detection for automatic windscreen
Wiping systems or cabriolet/roof closing	Wiping systems targa/sun roof closing
Integrated electric seat adjustment controls	Integrated electric seat adjustment controls
In-car 'infotainment' Systems	Integrated Infotainment systems
Night vision assistance	Night vision assistance
Colour head-up display	Colour head-up display for speed boats
Shock absorbing seats	Shock absorbing seats for the helmsman
Seat design for comfort	*Seating and damping both vertical and horizontal*
Crash testing, safety systems Euro-N-CAP	Crash testing, safety systems, life-raft regulation
Automated highway systems	Automated guidance systems – Dover, Bosphorus etc
Collision Avoidance System Actively avoid collision	Active Collision Avoidance System
Driver fatigue recognition systems	Driver fatigue recognition systems
Vehicle Galileo tracking system	Yacht Galileo tracking system
Automatic registration plate recognition for toll roads	Automatic registration plate and boat dimension Recognition for boat charging and reservation
Pedestrian safety	Diver/swimmer/drift wood warning system
Car Ergonomics-Chassis and Dynamic Stability	*Boat Ergonomics-Vessel motion, stability/turn holding*