

Research relating to New Passenger Train Interiors for 2020 and beyond, in Partnership with Government, Industry and Academia

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Abstract— This paper discusses a research and design project initiative undertaken in partnership with a UK Government agency, a manufacturing company and academia. The project relates to the development of high speed trains with in service speeds of 340kh and projected speeds in excess of 500kh, and the proposal that business people will be able to travel as quick, or more quickly and economically by train over longer distances in comparison with established air travel, both in terms of financial cost and in utilisation and effectiveness of personal time. The project is proactive design research driven through exploratory creative concept design that addresses the fast changing and challenging future travel needs and expectations of business and industry. The concept is for a dedicated business specific passenger train carriage. The carriage designed so that it is adjustable and flexible in structure, floor size and layout, accommodation, furniture, equipment and services provided, enabling business user/s to specify their business requirements in the pre-booking of travel arrangements. As an integral component of the project is the research and application of new and developing materials, technologies and manufacturing processes, and the influence these will have in the generating of new creative innovative design concepts and their development to design realization

Index Terms — Interior design, design technology, interior design issues.

1 INTRODUCTION

FROM the outset it was determined that the project would be based on proactive research and design methodology. The initially brief was to establish a design led innovative scenario outside the scope of current thinking that addresses the fast changing and challenging future travel needs and expectations of business and industry.

The design scenario concept is for a dedicated business specific passenger train carriage, the carriage designed so that it is adjustable and flexible in structure, floor size and layout, accommodation, furniture, equipment and services provided, enabling the business user/s to specify their business requirements in the pre-booking of travel arrangements.

Creative, innovative design led concepts have been generated and presented to potential users/clients for response and feedback. Feedback is showing the approach to be producing valuable input for continued project research, design and development investigation. As an integral component of the project is the research and application of new and developing materials, technologies and manufacturing processes, and the influence these will have in the generating of new creative innovative design concepts and their development to design realization. Factored into this is the need to be able to recycle the materials after an expected train carriage in service life of approximately 35 years.

In parallel to this, is the on-going consideration of the extensive ever-changing safety performance standards and regulations that appertain in a very multilayer manufacturer to rail operator regulated industry, and the effect that they have on new design.

Whilst the project is utilising many of the well established forms and processes for undertaking such a project, it is also

assessing how these might be better developed and incorporated for the generating, and communicating of design information in the creating of new advanced design concepts and their development. [This project is on-going, exploratory, and design for the future].

2 PROJECT INTRODUCTION

Since the introduction of the Shinkansen 'bullet train' in Japan in the mid 60's, high-speed train systems have been introduced and developed in many countries throughout the world, the largest being in China, Japan and Europe. At the moment China is leading the world with investment in new high speed rail networks to link urban centre's across the country. It will soon be possible to take a high-speed train starting from Hong Kong and to travel most of the major cities. [illustration 1] Japan is also at the forefront of new developments with its magnetic levitation [Maglev] trains. [1]



Illustration 1

Europe has a well-established high-speed rail network and spending on new high-speed rail lines is gathering pace to link up countries across borders. Europe intends to significantly increase the extent and number of connections by 2025. The long-term plan is to have a high speed Trans-European network for the whole of Europe. [illustration 2]



Illustration 2

The USA national long distance rail network is mainly single track that carries a significant percentage of slow moving freight train traffic. This coupled with other preferred forms of transport such as internal airline flights and the car, both of which are generally considered by the people of the USA to be more efficient in time and cost, also political factors, are the main reasons the USA has not developed high-speed train services. However, President Obama's government has recently invested \$8 billion to jump-start an ambitious nationwide high-speed rail travel network. [2, 3]

- High-speed trains offer distinct advantages over many other forms of transport -
- Greatly reduced journey times between city centres.
- Seamless journey experience from city centre to city centre.
- Genuine real alternate to airline and other forms of travel over certain journey distances.
- Considerable reduction in emissions when compared to airline travel, for example - "the emissions from travelling by train from London to Paris are 90% lower than that by air travel". [4] The French AGV train produces 2.2g of CO₂ per passenger per kilometre 70 times less than the passenger aircraft 153g. [5]
- More energy efficient when carrying high capacity numbers of travellers.
- In comparison to road transport, train transport has a smaller footprint on the landscape.
- Train stations are located in city centre's making travel more direct and convenient.
- Equipment facilities
- Service facilities - food, overnight travel, toiletry needs
- Perceive customer value.

These examples clearly identify the global trend towards increasing investment and operation of high-speed rail passenger travel because of the real and perceived future advantages that this form of transport is providing.

The planning, research, design and development of new and the development of existing high speed passenger train travel systems and passenger trains for the future is extremely complex, requiring significant financial investment, and taking many years to design, develop and incorporate. During this time many predictable and unpredictable events can take place, which may alter or modify direction. However, in planning for the future it is necessary to be proactive in the research, creation and exploring of possible scenarios, and designing and developing products for those scenarios to enable assessment and evaluation to be undertaken.

Based on research undertaken, forecasts and predictions, this project has been undertaken to explore possible passenger train travel scenarios, in particular the future travel needs and wants for the European business community, through the generation of concept design ideas.

3 THE PROJECT SCENARIO

Mobility and transport is no longer seen as purely the means to get from A to B. There is a clear trend towards travel being seen as an experience to be enjoyed whilst also providing somewhere to work and or socialise.

The on-going development of high-speed trains presents new opportunities and challenges to create exciting carriage interiors that will meet the needs and expectations of travellers of the future.

The project scenario is based on the current development

of high speed passenger trains that are being developed and tested with expected in service speeds in excess of 350km/h, (A version of the French TGV has been tested to speeds of 574km/h) (6) and the fast expanding European Union high-speed networks where it is predicted that as Europe becomes more and more integrated in terms of business, (currently 50% of all UK business and trade is with EU member states) (7) there will be an increasing need for business people to be able to travel as quick, or more quickly and economically by train over increasingly longer distances in comparison with established air travel, both in terms of financial cost and in utilization and effectiveness of personal time.

There are indicators that this is already taking place. In Spain, Italy, France and Germany the development of high speed train networks and the convenience and financial benefits they provide, is increasing affecting internal air travel in that some short haul air routes have been substantially reduced in response to user preference for high-speed train travel. The journey time for the 625 kilometres from Madrid to Barcelona by train is 2.5 hours, travelling at speeds up to 350km/h. (8)

The channel tunnel between the UK and France links the UK with high-speed networks in France, and as new high-speed lines become operative will extend the range and number of destinations that can be travelled. Italy now operates a fleet of 25 high-speed trains that travel at speeds up to 340km/h, linking Rome Turin, Milan, Bologna, Florence and Naples, reducing journey times by up to a third. (9)

Passenger research studies carried out for Eurostar, show that –

- Business travellers are prepared to spend up to four hours on their journey if they can work.
- Travel allows uninterrupted opportunities to work via laptops and mobiles en route.
- Time saved by travelling city centre to city centre aids productivity.
- Freedom and flexibility of direct boarding.

4 PROJECT AIMS AND OBJECTIVES

The project aims and objectives are to generate through a proactive research and design led programme, creative concept design ideas and proposals outside the scope of current thinking, for business specific rail carriages that addresses the fast changing and challenging future travel needs and expectations of business for the year 2020 and beyond, and the ever changing nature of business. The outcomes of which may help to identify, clarify and formulate future carriage designs that will serve the needs of the business community.

5 PROJECT BRIEF

The project brief is to generate through proactive research and design methodology, creative concept design ideas proposals for dedicated business specific passenger train carriages. The carriages to include appropriate support equipment and infrastructure to facilitate business people undertake their business whilst travelling. The carriages designed so that they are adjustable and

flexible in accommodation floor area layout and structure, and the furniture, equipment and services provided, to enable business user/s specify their business requirements in the pre-booking of travel arrangements.

Business traveller profile types are wide and varied from single business traveller to small to medium size groups, consisting of directors, sales executives, highly qualified specialists engineers, technologists, business support teams, etc.

Minimum facilities to be included for customer use are - phone, email, video links, and appropriate provision for group/team motivation trips. For long and/or overnight journeys there will be a need for food, personal sleeping and toiletry provision, the design and layout for sleeping depending on the requirements of specific user profiles, for example - the individual traveller, groups and the gender and otherwise nature of the groups, and the distance/destination of the traveller.

As an integral component of the project is the research and application of new and developing materials, technologies and manufacturing processes, and the influence these will have in the generating of new creative innovative design concepts and their development to design realization. Factored into this is the need to be able to recycle the materials after an expected train carriage in service life of approximately 30 years.

In parallel to this, is the on-going consideration of the extensive ever-changing safety performance standards and regulations that appertain in a very multilayer manufacturer to rail operator regulated industry, and the effect that they have on new design.

Whilst the project is utilising many of the well established forms and processes for undertaking such a project, it is also assessing how these might be better developed and incorporated for the generating and communicating of design information, in the creating of new advanced design concepts and their development.

Initial User factors to be addressed –

- Dedicated spaces to meet needs of passenger
- Passenger privacy and personal security
- Level of comfort
- Equipment facilities
- Service facilities – food, overnight travel, toiletry needs
- Perceive customer value

Other factors to be considered –

- Maximizing of space utilization/return on investment and ongoing running costs
- Materials and manufacturing processes
- New and developing technologies
- Legislative and safety requirements,
- Green issues – product life cycle and end of life disposal issues
- Maintenance /ease of cleaning

6 INITIAL DESIGN CONCEPTS

Two creative, innovative design led concepts have been generated and are currently being explored and developed. The design proposals are based on the main carriage structure manufactured from composite materials with modified heat-treated aluminium components, assembled using advanced high technology gluing techniques. One design concept is based on an adjustable screen partition system, that enables passenger areas to be adjusted in layout and fitted with furniture and equipment to specific customer individual, group and company requirements for any given journey. [illustrations 3,4,5,6 show various initial design ideas] Visual aesthetic design considerations for the partition concept are being explored, including the use of solid, part clear and obscured materials.

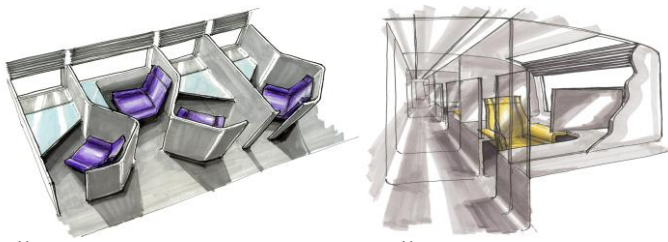


Illustration 5

Illustration 3



Illustration 4

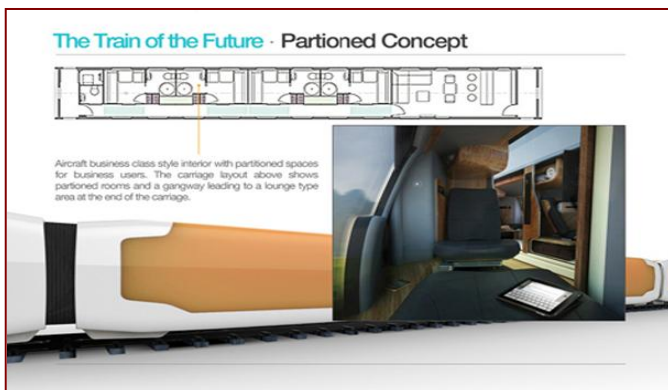


Illustration 5

The second design concept is more 'blue sky' and would require a greater level of change to current rail and train operations systems and infrastructures, therefore a high level of commitment from not just the train manufacturers themselves but depots and rail line operators.

The design concept is based on having a standard coach chassis that can accept a range of various modular cabin designs that are loaded and locked onto the chassis to form a complete carriage, each cabin fitted with furniture, equipment and support services to specific client/customer requirements. [illustrations 7 and 8 company dedicated carriages, illustration 9 a design proposal for a carriage interior. Illustration 10 design proposal for a company meeting area]

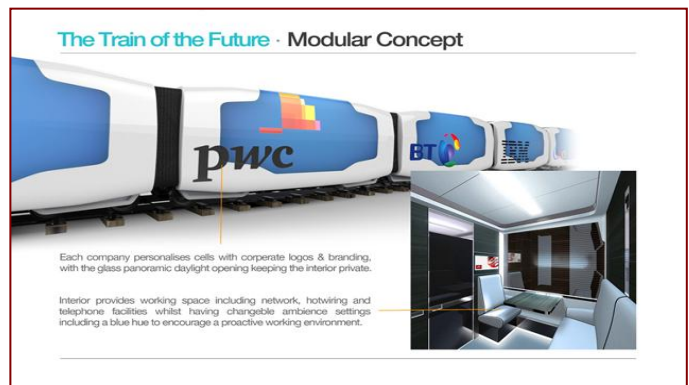


Illustration 6

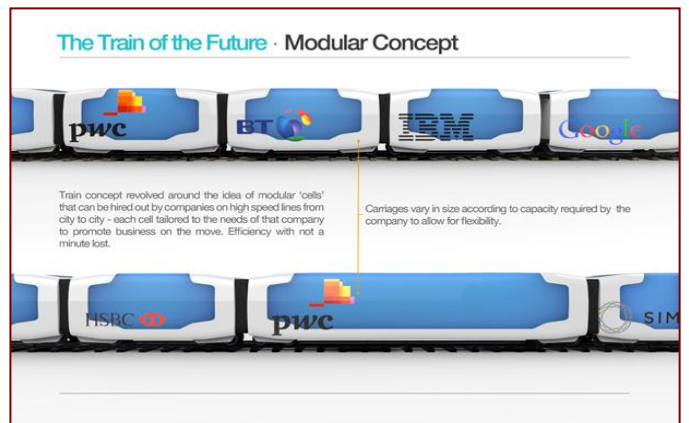


Illustration 7

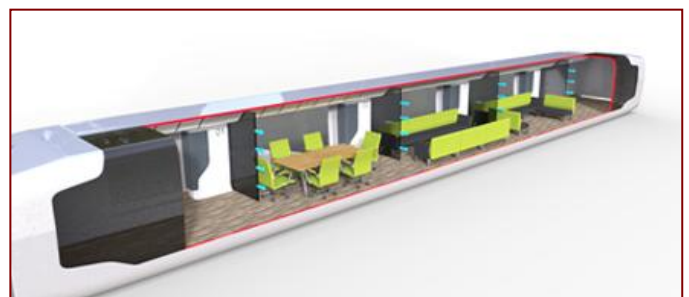


Illustration 8



Illustration 9

At present, business travellers for the duration of their travel, from leaving the city centre until they reach their final destination, have limited facility and access to company, office, or clients. The modular carriage concept is designed to enable business travellers to hire, rent, lease carriage space that would be tailored specifically to their needs, effectively providing a moving office work environment space.

The design of the furniture and equipment is based on flexibility and adjustability, to function in many different floor plan layouts, without compromising the effective utilization of space. Also being considered is the equipment options and inbuilt plug-in service facilities, including phone, email, Internet, video conferencing, screen displays.

After formulating the two main themes for high-speed rail travel based around initial research, the design concepts were shown to UK industry stakeholders for response and feedback. The initial feedback received suggests that both concepts have potential. The feedback is being assessed and where appropriate will be applied in the ongoing design and development of the design concepts. Examples of feedback received are as follows –

- *"As far as the overall concepts go, a modular train, as a schematic, seems like a good idea, however it would present a number of issues with regards to infrastructure and methods in changing the modules in the train".*
- *"The business on the move idea certainly has legs; I think this idea can be extended further on high speed city to city links".*
- *"The most popular was the first class aircraft style interior which is something that I believe will be worked towards in the UK on the proposed high speed lines".*
- *"It is important for these new interiors to give the "wow" factor to passengers, and the images certainly have the potential to do that".*

With both designs it is important to change perceptions within the industry as well as the perception of train users. There has been inconsequential change in the design of train carriage interiors over the last 50 years in comparison with other methods of transport, particularly air travel. This is due, in part, to the level of investment within the industry. Many industry insiders have become accustomed to this slow change

and will need to be convinced of the real, tangible benefits that high-speed train travel can bring.

Evidence of this was apparent in some of the feedback received from industry, to quote –

"The design concepts were presented today and as you might expect the more conventional ones [designs] were liked best by the largely "old railway" audience".

7 NEW TECHNOLOGIES

Passenger train carriage manufacture has for many generations been undertaken on traditional mechanical assembly techniques, based on long well established knowledge and skills abilities, therefore, is low risk.

In the process of designing, research has been undertaken with regard to existing, new and developing materials and manufacturing processes. In particular the use of lightweight materials, structures and associated manufacturing processes.

It is evident that certain advanced technology based materials and processes currently being used by the aircraft and racing car industries in the products they manufacture, have application for the design of high-speed passenger train carriage structures and interiors, in that the product performance and safety requirements for the these industries have related similarities. The new Boeing 7E7 'Dreamliner' passenger plane [illustration 11] and the new McLaren high performance road car, (illustration 12) both of which have been structurally designed to be manufactured from lightweight composite and other high technology performance based materials, are examples of this. [10][11]



Illustration 10



Illustration 11

The reduction in weight is seen as a primary focus in the rail industry as not only does it give obvious benefits to fuel consumption but also keeps axle loads down reducing incremental damage to the track, and in turn reducing the regularity of track replacement and maintenance programs.

Composite materials offer several advantages in the proposed design concepts –

- The ability to manufacture a large one-piece moulded lightweight structure
- Ease of manufacturing body form and surface smoothness
- The ability to integrate integral structural components, partitions, furniture, equipment, etc.

Although these materials and manufacturing processes are relatively expensive at present, the need for manufacturers to address increasingly more demanding product performance specifications, particularly with regard to product and technical performance, ecology issues such as CO2 emissions and

recycling, and the reduction of product costs, is driving industry to develop cheaper new high technology, high performance materials. [14][15][16]

Research undertaken on the comparative life cycle costs of passenger cars, produced using traditional metal manufacturing methods compared to equivalent cars incorporating various lightweight composite materials, is showing that there are distinct cost benefits, plus the environment issues of fuel saving and reduction in pollution. [17]

Along with improvements in aerodynamic and weight reduction performance, train manufacturers have identified additional processes that have been used in performance motor-ing, such as regenerative braking, that can be used in the design of next generation trains to increase fuel efficiency. A recent Siemens study indicated that regenerative braking might recover 41.6% of the total energy consumed. [17]

8 IN CONCLUSION

The content presented shows the initial outcomes of an on-going exploratory proactive design research programme. The project is future based addressing a number of unknown factors therefore the work undertaken is based on aspects of re-search, certain assumptions and creative design input. One of the objectives for the final outcomes of the programme is to create a platform for dialog, as to what the nature and design of high-speed rail carriage interiors for business travellers for the year 2020 and beyond, might be. In the process contribute to formulating a more informed perspective as to the future needs of business travellers.

9 ILLUSTRATIONS

- [1] Map showing high-speed train network in China. Johomapa 2006-11
- [2] Map showing high-speed train network in the European Union
- [3] Illustration and sketch of partition system. Authors of paper
- [4] Illustration and sketch of partition system. Authors of paper
- [5] Illustration of partition system. Authors of paper
- [6] Modular design concept. Authors of paper
- [7] Modular design concept. Authors of paper
- [8] Modular design concept. Authors of paper
- [9] Illustration of meeting/conference area.
- [10] Boeing 'Dreamliner' aeroplane. Main structure uses composite materials. Boeing photo
- [11] New McLaren high performance road car, structure composite materials. McLaren.

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