Changing the Climate of Public Transport: A Design Research Initiative

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1.0 Introduction

The *Public Transport Design Research Initiative*, developed by Monash University's Faculty of Art & Design and the Institute of Transport Studies in 2005, aims to develop original and innovative design concepts and approaches to address the challenges faced in the design of future public transport vehicles and infrastructure. The initiative is part of *Monash Transport*, a multi-disciplinary and inter-faculty network at Monash University. The initiative aims to:

- promote the unique challenges faced in designing public transport vehicles and infrastructure within the design industry;
- develop knowledge and learning about design in the public transport industry;
- upgrade the quality and breadth of design inputs used to create new public transport vehicles and infrastructure; and,
- create equality in design between the automotive and public transport sectors.

This paper presents some of the outcomes from a developing series of design projects run as part of this Initiative. To date, over fifty design proposals have been presented as part of the undergraduate design program, and recently two design PhDs in public transport have developed as part of the growth of the Initiative. The paper predominantly discusses two major undergraduate studio design projects.

The first of these projects showcases a series of case studies that responded to Melbourne's 2030 plan, and in particular the proposal to increase public transport usage to 20% by the year 2020. The selected case studies highlight not only the diversity of design solutions that resulted in three State Awards, but also the unique approaches to undertaking the studio project.

The second project discusses the *Melbourne Lightrail Towards 2020* competition where teams of Victorian tertiary design students were asked to design a tram for Melbourne based upon Alstom's Citadis platform. This paper presents a brief overview of five case studies that made it to the finals of the competition, including the winning team.

2.0 Project One overview

What will, or could, be the future of public transport? Using Melbourne as a case study third year Industrial Design students were asked to investigate this question, and present pertinent, practicable, and realisable design proposals that address some of the key issues and problems relating to this area. The project focused upon Melbourne's 2030 plan, and in particular the proposal to increase public transport usage to 20% by the year 2020.

Melbourne 2030: Planning for sustainable growth (DOI, 2002) is a 200-page document produced by the Victorian Government outlining nine key objectives, or "directions', for the sustainable development of Melbourne. *Direction 8* focuses upon transport issues, and the document notes that, "not surprisingly, in the consultation process for *Melbourne 2030*, transport emerged as a dominant theme. It also proved to be the feature Melburnians liked most and least about their city." (DOI, 2002, p iii) To this end, the document provided a useful context and resource for a challenging student design project.

The semester-long project was structured such that there were four intermeshed stages to the project; investigation & research; ideation, concept development, and modelling and documentation of the final design. Whilst some of these stages were concurrent and naturally overlapped, each of the stages culminated in a presentation that was either critiqued or assessed.

To extend the students' initial ideas and provide a solid foundation for further design and study, the class was divided into groups of 3-4 people to investigate specific aspects and problems of public transport, both locally and internationally. The groups were also asked to prepare a set of mood boards that would help articulate the culture of Melbourne, its people and its transport system. The groups' findings were presented in the second week of the project and were then used as a joint class resource.

The investigation and research stage of the project culminated in a 'case' for the project – in essence, an in depth investigation to provide the context and justification for the student's project, covering such issues as:

- an explanation and analysis of the problems and issues that justify the design direction (i.e., how the project came about and its significance, social analysis, design issues);
- a review of the state-of-the-art (results from literature search, review of both current and future public transport vehicles and systems);
- a forecast (i.e., social, cultural, working and design trends, demographics, emerging materials and technologies); and,
- an outline of the implications and predictions based upon the Melbourne 2030 plan, with specific reference to Melbourne in the year 2020.

From the outset of the project students were encouraged to creatively explore ideas and possible design directions both independently, and in collaborative groups. The ideation stage consisted of group brainstorming and individual concept generation which was peer critiqued in the third week of the project. Post-critique, students selected one key concept or theme to further develop and refine. The 'case for the project' and a focused concept were presented in the sixth week of the project, allowing a further three weeks of concept development before a final design was presented for assessment in the ninth week. Hereafter, the design was refined, a physical appearance model was created, and key documentation and presentation material were developed.

3.0 Project One case studies

A wide range of innovative transport solutions were proposed by the students and these were showcased in a public exhibition at the end of the Semester, where various stakeholders in Victoria's public transport industry were invited. About 25 proposals were showcased from the class – the vast majority were from individual students, but two group (or team) projects were also shown. This paper focuses upon just four of the proposals that representatively highlight the diversity of design solutions, and their unique approaches to undertaking the studio project.

3.1 *Transport Fusion*

A group of six students formed a team early in the semester, based upon either similar or shared ideas (but not necessarily shared philosophies). The final proposal was an express train that never stops, yet allows passengers to get on or off at any station en route via sub

carriages that attach and detach from the train and bank at street level. Figure 1 shows the final model.

Figure 1. *Transport Fusion*

The innovative idea, whilst immediately questioning feasibility, was rigorously explored and presented in a convincing and believable way. The team's strength was in the broad range of tools used for design exploration – both analytical tools and synthesis tools were confidently utilised. The project began with the idea of a 'zipper', whereby carriages could join or leave a train thus eliminating the need for the train to slow down or accelerate at stations. Whilst the team devised various mechanical methods by which the interlinking could happen, they found themselves primarily very pre-occupied with establishing a case to justify the project. Herein lay some interesting observational fieldwork, and a case study of a particular train line on the Melbourne network; the team measured times and distances between stops, and counted the total number of commuters as well as the commuter movements at each station, which was then compared to the total capacity of the train.

The data were put into a spreadsheet to help analyse inefficiencies of the current train network and also to identify opportunities to enhance the capacity of the train whilst reducing the overall duration of the journey. The tool was powerful and convincing, as it provided relational comparisons of the team's own concept to that of the current system. The tool helped in bringing realism to the proposal, by being able to predict proposed train speeds, the number of carriages required, the timing and distances between stops, and so on, thereby evaluating the benefits of their proposed system over the current one.

The design concept was explored and developed using a number of typical design tools, such as sketching (both freehand and digitally using Alias® Sketchbook™ Pro), three-dimensional models (physical and digital), animations, and full-size spatial mock-ups. The team also experimented with using a green screen, and video-editing software to fuse video footage of themselves with a digital animation of their train. The digital modelling literacy of some of the members of the team was particularly good, and so it was not uncommon in class to be discussing something like egress issues with the team, only to be presented with multiple animations outlining design alternatives that were prepared during the discussion.

3.2 *Cybus*

Policy 8.7 of the Melbourne 2030 plan states the intention to "Give more priority to cycling and walking in planning urban development and in managing our road system and neighbourhoods" and Policy 8.7 intends to "Promote the use of sustainable personal transport options". This, in part, formed a useful argument in support of *Cybus* – a bus that

accommodates cycles in the back to allow cyclists to make use of the bus service in much the same way that cyclists currently take their bikes onto trains to extend their journey options (see figures 2 and 3).

The final design utilised an electro-mechanical system of lifting and re-orienting bikes to store them vertically in the rear of the bus. Other key areas for design development were in space layout/planning, the ergonomics of loading and unloading bikes from the bus, and exterior styling to update the image of the bus. This project won the Bus Association of Victoria prize for the best bus concept at the Exhibition opening.

Figure 2. *Cybus* exterior scale model

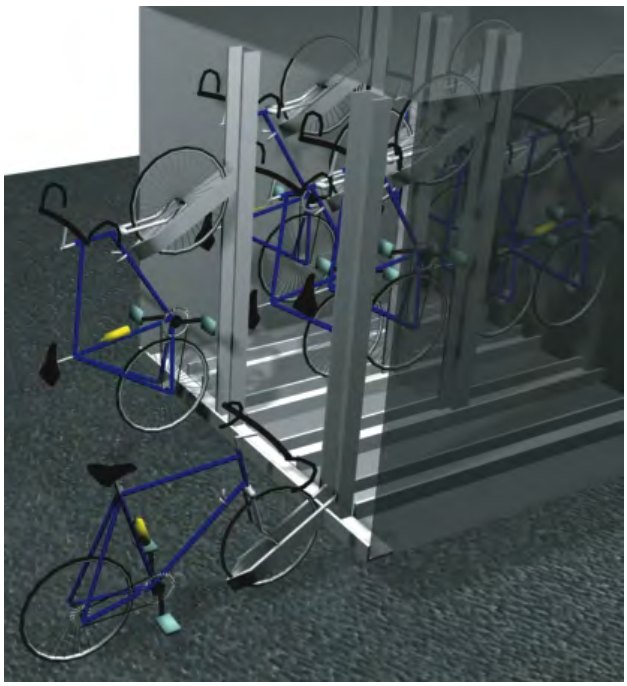

Figure 3. *Cybus* loading mechanism

3.3 *Smart Train*

The *Smart Train* (figure 4) proposal was a merger of personal and public transport. The proposal allows small cars to drive onto a dedicated train carriage to continue a journey along a fast train, thereby speeding up commuter times. In this case, the proposal argued that the car would typically be used for short journeys (for instance, commuting from home to the *Smart Train* station, and from a station in the city to work), and the majority of the commuting distance would be covered by the *Smart Train*. The proposed benefits for commuters would be the convenience, cleanliness and comfort of a personal vehicle, but the benefits of reduced commuter times, increased safety, and reduced vehicle emissions. In addition, whilst aboard the *Smart Train*, passengers could utilise the wireless internet facilities on board to work during their journey.

This proposal was particularly relevant for commuters from outer suburbs and country locations to avoid congestion on freeways and major highways, and tied in with the Melbourne 2030 plan for population growth in selected outer suburbs, as well as provincial towns and cities in Victoria. The project looked at the growth of the small car market, with a particular focus on the *Smart* car, as this provided a great aesthetic cue, philosophy, and marketing opportunity to promote the system. This proposal necessitated consideration of the road and platform infrastructure, in addition to the train carriage itself, and in so doing expanded the project to include the *Smart Train* station and platform to allow for a more cohesive system.

Figure 4. *Smart Train* model

3.4 *Single Track Tram* system

Two students formed a team to take Melbourne's iconic trams and present an innovative proposal to update them and, importantly, make them more accessible in accordance with the Federal Disability Discrimination Act. The Disability Discrimination Act states that by 2032, all trams/tram stops must be accessible – this is a significant challenge given that currently 68% of the 1,200 tram stops in Melbourne are kerbside stops and passengers have to climb aboard the tram from the road (Currie, 2005). The team also identified traffic congestion as a major problem that current trams are, in part, responsible for given that the majority of light rail track is inter-mixed with road infrastructure.

The team's proposal was for a small single-rail, gyroscope-stabilised tram allowing trams to go in both directions simultaneously along the same set of tracks. The reduced width of the trams would free-up road space within the inner city, providing an additional lane of traffic if needed, thus reducing traffic congestion that typically banks up behind the current trams.

Because the trams are much narrower, there is the potential to provide a more extensive light rail network, allowing access to Melbourne's laneways and narrow roads, at a reduced cost as only a single track rather than a set of tracks is required. Figure 5 shows an image of the *Single Track Tram* in situ in Melbourne.

Figure 5. *Single Track Tram*

Core to the proposal was the design of tram stations straddling the current tracks, making a central island that provided level access to the trams. These stations could be moveable, allowing them to be repositioned anywhere along the tracks to create stations when and where they were needed, or combined to form larger stations (thus catering for seasonal sporting events, for instance). The stations not only would provide a pleasant waiting area, but the space could be utilised as retail or hospitality space (see figure 6).

Figure 6. *Single Track Tram* station

The team approached local council planning authorities and developed their design relating to an actual site to highlight and demonstrate the strengths and feasibility of the proposal, covering such issues as disability access, traffic and pedestrian flow, urban development,

and pedestrian crossings. The strength of the project was in combining visionary thinking with rationalism to not only fulfil the requirements of legislation and the local council planning authorities, but to do so by presenting additional opportunities for retail space (in the middle of the tracks). The two team members, although industrial design students, found themselves working across other design disciplines, so the final presentation covered furniture, transport, infrastructure, urban, architecture and interior design.

This project won both the Premier's Student Product Design Prize, and the Premier's Student Design Award 2006. The judges said that the proposal "comprehensively addressed both the human and the technical factors in a well conceived and delivered presentation, which is particularly impressive as a student work. It demonstrated design excellence and design innovation in transportation and product design, which also serves as a critique of current systems and provides an imaginative vision of possibilities for the future." (Premier's Design Awards 2006)

4.0 Project Two overview

Trams are considered a Melbourne icon and are seen as an essential part of the city; indeed, Melbourne has the biggest light rail network in the western world. There are, however, a number of problems of the current light rail infrastructure and the trams that use it, not least of which is that this network is not readily accessible by people with disabilities. This, in part, became the stimulus for the *Melbourne Lightrail Towards 2020* competition, where teams of Victorian tertiary design students were asked to design a tram for Melbourne based upon Alstom's Citadis platform. The project was hosted by *Lab.3000*, a centre for design funded by the Victorian Government and RMIT University, and students were specifically tasked to "take into account future social needs as outlined in the *Melbourne 2030 Plan*, the changing nature of commuter expectations, computer terminals and network points…The competition has been devised to challenge and engage the students, and consider a range of social, environmental and technical issues relating to Melbourne's transport network. These may include transport's sustainability, cars in the CBD, use of the tram system for senior citizens, the disabled, bicycle users and parents with prams. " (Lab.3000)

Mirroring the process of Project One, but with a different group of students, the project was carried out in a shorter time period typically in teams of three students. The class quickly developed sketches and provisional mock-ups to explore a range of ideas, making rapid progress on the development of their tram concepts. Alstom had provided initial specifications and drawings of their Citadis trams, and these constraints allowed students to pragmatically explore ideas and reduced the amount of deliberation typical of a more open-ended brief such as the of Project One.

Half way through the project a class critique was held attended by Xavier Allard, the Vice President of Design & Styling from Alstom Transport in Paris, who offered comments on the design directions of the teams. Post critique, the teams developed their concepts and began body storming (a technique of interacting with full-size mock ups) to finalise the interior layouts and the final exteriors.

5.0 Project Two case studies

A total of 14 trams were proposed by the class, with 12 teams entering into the competition. Of the 28 entries from across the State of Victoria, ten teams were short-listed for the second round of judging – five of which were from Monash University, including first and third place winners of the competition. This section briefly describes those five finalist entries.

5.1 *Illustra*

The tram that is *Illustra* presents a digital canvas, whereby the exterior is coated in organic light emitting diodes (OLEDs) that act, to all intents and purposes, as a very large display medium for both static and dynamic images. The imagery can promote local and international artworks and even dynamically present, in realtime, the creation of artworks.

The luscious interior presents a cultural tapestry threading its way through the cultural richness of the city as the tram progresses on its journey. The translucent partitions in the tram have imagery embedded within them, and the patterns incorporated in the seating fabrics have visual references to various historical and cultural events of Melbourne. One of the key intents of this tram is to discover more about the city and its cultural and artistic base through the tacit cues within the interior and passengers' curiosity is rewarded. The interior also acts as a gallery whereby looking out of the glass walls the city is presented as an artwork in its own right. Figure 7, below, shows the interior of the *Illustra* tram, with an image of the exterior on the front cover of the *MX* newspaper.

Figure 7. *Illustra* interior

5.2 *Discreet*

The team responsible for the *Discreet* tram were fascinated by the contrast between the conservative side of Melbourne, with its traditional Victorian architecture and leafy parks, and the more vibrant and bohemian underground sub-culture hidden down remote laneways, in funky galleries, and in nightspots. The team describe the tram as "representing the visual contrast between the two faces of Melbourne. There exists the conservative, fairly contemporary city that is portrayed to the rest of the world, but beneath that image lies an underground world of hidden nightspots, cafes, gardens and artworks". The exterior of the tram, through the use of aluminium and glass panelling, is reflective of the architecture of the city – indeed, the tram literally reflects the city – thus representing the contemporary Melbourne that many see it as. The interior, by contrast, "pays homage to the hidden world

that many are simply unaware of. While every effort has gone into creating an exciting visual representation of this hidden microcosm, through the use of bar seating, club lighting, electroluminescent lighting highlights and natural timber ceiling panels, the design is not without functionality. The doors of the tram slide outwards and sideways while an integrated ramp lowers, creating a wide access point suitable for disabled and wheelchair access. The divide between the two façades of Melbourne will only grow over time, as the city advances. Thus, the *Discreet* tram reflects this cultural contrast, the true definition of Melbourne." Figure 8, shows the interior of the *Discreet* tram.

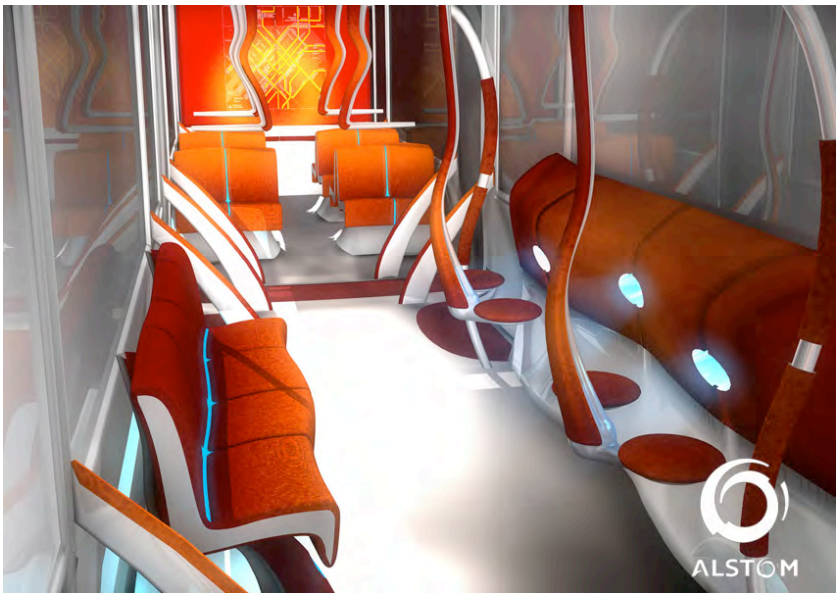

Figure 8. *Discreet* interior

5.3 *Three Musketeers*

In the vein of "one for all, and all for one", this highly industrious team set out to develop a tram concept that addressed the diverse range of Melbourne's current and future tram users. A range of typical tram users were identified and categorised on a bi-axial chart (figure 9, below) to help articulate user profiles which informed a list of users' needs and wants.

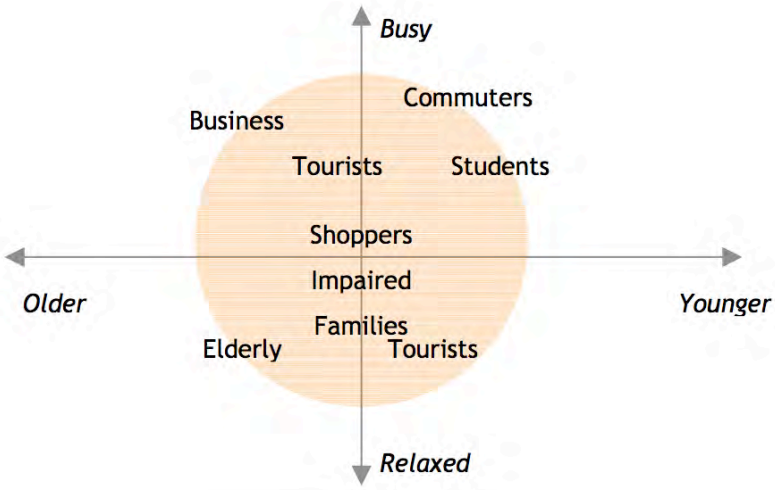

Figure 9. Bi-axial chart representing a user map

The final tram is shown in figure 10, and was described as, "Quick, clean, safe, efficient and the personifying qualities of being approachable, friendly and reliable. Melbourne is renowned for its arts, cafes, gardens, nightspots and visually appealing skyline. These are elemental features that have been incorporated in the design, by considering the tram's appearance from every viewing angle. For instance, most trams utilize the roof space of the vehicle to house air conditioning units and the pantograph without much consideration of how unsightly the tram appears when viewed by people looking down upon the vehicle. Yet, considering much of the city consists of high-rise offices, the appearance of the tram's roof should be an important consideration. In response to this, the exterior of the *Three Musketeers'* tram hosts a "Garden Roof" – a green strip simulating a grass nature strip – that flows down the tram's roof covering the air conditioning system. In the interior, the ceiling contains translucent glass with a superfine dot matrix screen behind that can project the exterior environment to the inside of the cabin so, to all intents and purposes, the ceiling appears to have a very long continuous skylight. This "skylight" can of course show other imagery, and useful information for passengers, and acts as a lighting system too (alerts and information can be given to all in the carriages and assist with emergency management, for instance). In addition to the "skylight", directory listing maps showing real-time positioning, and tourist places of interest relative to the tram's location will intermittently be displayed on a series of screens.

Figure 10. *Three Musketeers* concept

5.4 *Chili Hazard*

Chili Hazard took third prize in the competition, and incorporated a number of novel features based on lighting. The tram incorporates light projections onto the road providing a guide for passengers to get on and off the tram and, like the *Three Musketeers* concept, a long screen on the ceiling of the tram would show sky views, whilst OLED windows present timetabling information to passengers and prospective passengers. Figure11 shows the tram in context.

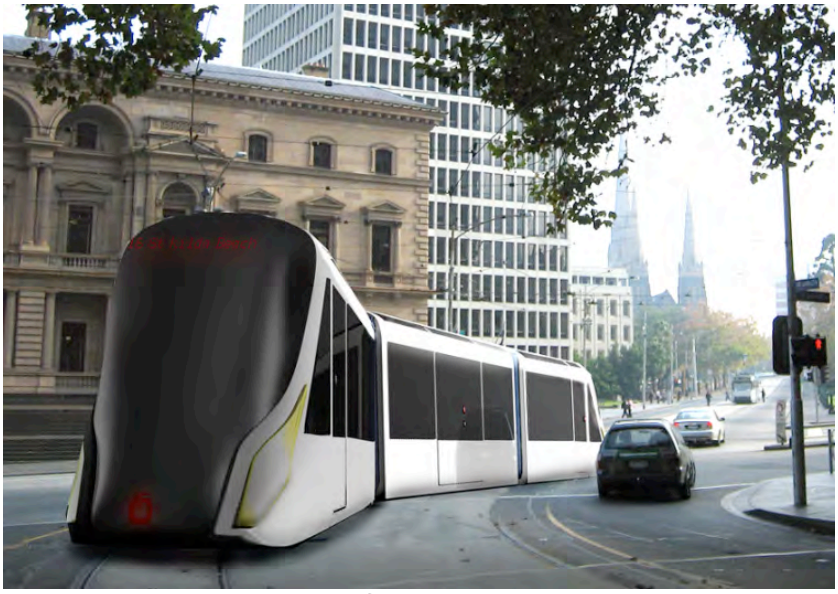

Figure 11. *Chili Hazard* exterior

5.5 *Vista,* by Team *Yokopano*

The Vista tram won the overall competition, with the judges commending the concept as "a bold design … the further you look the more surprises you find. The ideas for improved passenger safety in particular were quite revolutionary". Similar to *Chili Hazard*, light projections onto the road present to pedestrians and other road users a warning that passengers are about to alight the tram. These projections also aid passengers by highlighting the road way and any tripping hazards. Illuminated signs at the rear of the vehicle inform traffic following the tram of whether the tram is stopping or about to take off. Inside, the seating utilises a gel material for greater comfort and hygiene, and an interactive information system keeps passengers informed of the status of their journey. Vista's strength was in presenting a clever and modern update to the tram whilst demonstrating how practicable and achievable the developments were. Figure 12, below, shows a digital rendering of the winning concept superimposed on a Melbourne streetscape.

Figure 12. *Vista* exterior

The prize for the winning team was a two-month internship at Alstom Transport's design studio in Paris where the team worked on the further development of the Vista proposal.

6.0 Conclusions and reflections

The unique challenges faced in designing public transport vehicles and infrastructure provided a rich context for design enquiry within the studio allowing students to combine visionary thinking to cater for the needs and wants of a wide diversity of the population, whilst taking account of the pragmatic constraints of legislative and policy requirements. Public transport, as a topic area for design education, presents a useful design problem to tackle. Discussion on the nature of design problems is well documented, see for example Buchanan (1995); Cross (1998); Cross & Cross (1995); Jonas (1993); Lawson (op cit); and Margolin (1995). Design problems are: notably ill-defined (Cross & Cross, op cit), often not apparent but must be found (Lawson, 1990), complex, difficult to resolve (Lawson, 1990), and intractable, nebulous and inter-linked (Lawson, 1990, Buchanan 1995).

"The ill-defined nature of design problems means that analysing and understanding the problem is an influential part of the design process." (Cross & Cross, 1995, p144) Ill-defined problems, and 'wicked problems' (first coined by Karl Popper, later developed by Horst Rittel (1984) to describe the nature of design problems and then discussed by Richard Buchanan (1992), are commonplace in design. The difficulty is often in defining the problem: various questions will play on a designer's mind, allowing meaningful exploration of the underlying problems behind a design brief or design need.

In the context of the *Public Transport Design Research Initiative*, students had to grapple with a future scenario (Melbourne in 2020-2030), complete with a set of unknowns, or at best speculations and predictions about the future. Equally that future was grounded in and by Melbourne's current road and public transport infrastructure. Thankfully, the *Melbourne 2030* plan provided a rich resource to cite and refer to regarding planning and demographic requirements in order to help define the problem, and hence justify the students' proposals. Predictions of materials, technologies, future trends and aesthetics, population needs, wants and desires, and so on, were far more speculative, but nonetheless the students tackled these areas well.

The success of the *Initiative* was not only in the varied and innovative outcomes, but moreover in the development of the student designers themselves, and how they dealt with conflicting requirements, wrestled with complex design problems, and developed their capacity to design and manage a project of this nature.

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Discreet:	Avon Perera, Matthew Thomson
Three Musketeers:	Angelo Pachioli, James Nissen, Alan Tam
Chili Hazard:	Tai Chiem, Dolly Yansen, Pok Hin Chua
Vista by Yokopano:	Chris Chan, Casey Phua, Yu Chen Pan

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