3.0 ISSUES GROUP SUMMARIES

3.1 LEADERSHIP

By Reg Hobbs
Flagstaff Consulting Group for The Warren Centre

3.1.1 TERMS OF REFERENCE

Risk Management

Considering the industry leadership necessary to develop solutions to satisfy the realistic contractual and risk management needs of a client base that is increasingly reliant on private sector finance (banks, mezzanine financiers, equity markets and super funds dictating terms) for private sector developments and government works (Public Private Partnerships, office leases etc).

Sustainability

Considering the industry leadership necessary to respond to increasing demand by all types of clients for sustainability in design and materials use – noting that steel may not be perceived as offering the best solutions at the present time.

Changing perceptions

Considering whether steel industry leadership should begin promoting best use of the combined advantages of steel and concrete rather than the old steel versus concrete mindset.

Education

Considering how the steel industry may foster new initiatives to enhance education of architects, engineers, para-professionals and others to gain the earliest possible familiarity and comfort with the uses, applications and technology of steel as an everyday construction material.

Safety

Considering whether there is a need for greater leadership in temporary works design and responding to recent and future changes in Occupational Health & Safety (OH&S) legislation affecting use of steel.

3.1.2 DISCUSSION

Time and resources did not permit consideration of the education issue in any detail, however it is considered to be an important matter for the steel industry to consider further and is worthy of development of long-term strategies.

The issue of sustainability generated a significant amount of discussion. The most important task for the group was to form a view on whether it was an issue that had real potential to affect the adoption of steel for building framing. The group concluded it is a major issue and that the pace of change in adoption of the various 'green building' rating systems in Australia by government, property investors and commercial developers has been very significant during the past two years.

The need to focus on leveraging the best features of steel and concrete in a building design and not continuing the eternal steel versus concrete debate was quickly and unanimously agreed upon by the group.

A workshop, held in Melbourne, with construction industry leaders from the government, finance, developer and legal sectors gave great insight into influences on the decision-making process used by developers, building owners, financiers and tenants. A salient example was that developers do not care whether a building is framed using steel or concrete; what they want is a solution that minimises construction time across all trades (not just the frame), is more economical to construct, will achieve 'Green Star' ratings or other environmental criteria and is a flexible asset that ensures a high return on investment. Also noted were current trends for the government sector to use outcome-based contracts to procure accommodation in buildings, under a variety of innovative procurement models, which demand high standards of functional performance, environmental sustainability and life cycles.

The workshop also produced some strident feedback for the steel sector in relation to the level of resistance to the use of steel framing expressed by a number of leading Victorian building industry executives and one of the lawyer participants during his research prior to the workshop.

Somewhat inclusive waste discussion of the issues involved with skill levels in temporary works design and limited discussion of aspects of engineering education and development. Some areas of concern were noted, however no obvious means of addressing these could be formulated in the limited time available for this study.

Some surprising outcomes of the meeting with leading consultant engineers, Russell Keays and Emil Zyhajlo, were the observations of the latter after his recent three-month assignment in the UK.

Mr Zyhajlo suggested that one of the reasons that steel framing is more prevalent in the UK may be that British concrete design and construction techniques are significantly less developed than in Australia and other countries. He presented a number of specific examples of pre-stressing design issues, outdated approaches to formwork, limited use of high-performance concretes (prevalent in Australia for more than 20 years) and industry mindsets regarding costing, which indicated that his view had significant merit. In many respects what is "state of the art" in UK concrete frame construction is 10 or more years behind Australia. It is possible then that over the next 10 years the market share for concrete in the UK may grow and the relative usage of steel framing may fall[1].

The key question raised at meetings was where the leadership will come from to address the issues that so clearly affect the use of steel in buildings. In every case the issues group concluded it was not reasonable to expect the major steel manufacturers to be the sole leaders or to simply provide increased funds for industry development and reform, rather leadership and change must come from all levels of the sector.

The Group also discussed whether the steel sector could develop a larger market share in the low rise and typical suburban commercial market and noted this type of structure should be ideal in steel framing as the upper level and roof of a typical suburban office building is already usually steel framed. It was suggested engineers who typically design the structures of such buildings might have inhibitions about using steel because they do not enjoy the benefit of adequate composite design standards. Many will not be prepared to develop designs involving composite details or moment continuity where there is not an explicit standard for building regulation compliance and liability reasons.

1 Formwork for post-tensioned (PT) concrete construction is not overly complex either, and reinforcing steel and cable assemblies also bear relatively fixed ratios to concrete volume for specific types of structures.

Appendix A3 to this report presents a fairly uncompromising discussion of issues arising from the manner in which the steel construction sector presents itself to the potential specifier and client base noting how there appears to be a significant mismatch of expectations by both.

It is considered important to put these positions as there are no indications of the "take up" of steel framing for office buildings improving, particularly in the Melbourne market. When the Leadership Group began its deliberations there were two major steel-framed buildings under construction in Melbourne, both the subject of case studies by The Warren Centre and reported as being "state of the art" examples. In the 12 months since, a significant number of major office buildings[2] have started construction in Melbourne or are now being designed. Most of these buildings have not adopted steel framing and it is unlikely there will be any, even those being constructed by the builder, Multiplex Constructions, who adopted steel for the buildings that were the subject of the case studies.

2 The Cbus Property development in Bourke Street, the AXA Building at Docklands, the Ericsson building at Docklands, Waterfront City Docklands (mixed use), 399 Bourke Street (mixed use) and, it appears, the very large ANZ headquarters are most likely to be concrete framed.

3.2 VALUE CHAIN

By Aruna Pavithran
Lucis Pty Ltd for The Warren Centre

3.2.1 OBJECTIVE

As mentioned in Section 1, steel-framed construction has a much lower share of the multi-storey construction market in Australia than it does in the US or UK. This assessment was conducted to better understand the steel-framed construction value chain for medium-rise commercial buildings in Australia and where there might be opportunities to improve it. The medium-rise market was selected by the Steering Committee as a sizeable market with good potential for growth in steel usage.

3.2.2 METHODOLOGY

A case study approach was adopted to produce an empirical and factual analysis, in the style of an internal benchmarking analysis. The quantitative analysis for the assessment was conducted in three parts – cost, time and risk – to determine how each of these impinged on the efficiency and effectiveness of the value chain.

The sample assessed comprised four steel-framed buildings and one concrete-framed building, as discussed in detail in section 4.3.

3.2.3 FINDINGS

The analysis of this sample showed no systematic effect in the use of a structural steel frame on overall construction outcomes when compared to a similar concrete-framed building. The case studies show a range of steel-framed construction outcomes, some that are more cost- and time-effective relative to concrete, some that are similar and some less. The findings contradict a fundamental perception held in the market that steel framing is consistently more expensive and difficult to implement.

Cost

Three of four steel-framed cases studied were less expensive per square metre of Gross Floor Area (GFA) than the concrete comparison. Where steel was less expensive, detailed cost analysis showed that structural steel added 6–13 per cent of Total Construction Cost to the relative cost of a frame, and saved 7–12 per cent of Total Construction Cost in preliminaries and wages compared with the concrete case study, summing to little or no effect on relative cost in each case. This suggests that the additional costs in steel framing are saved in people-related site costs.

Time

Analysis of construction time showed no observable relationship between the use of steel or concrete framing and the time efficiency of construction. It also showed that the use of techniques such as the 'jump-start' do not always result in a comparatively faster time to completion. With consistent affirmation from project managers of the speed of steel-frame erection and jump-starts, this suggests that the benefits of these strategies are not fully realised in practice.

Risk

Issues considered to be common difficulties in the use of structural steel, such as long lead times, had no observable impact on the value chain. Of the realised risks observed in the case studies, the greatest source of 'normal' risk in the construction value chain is in the way the builder chooses to program erection. This is referred to in this report as Building Proposition Risk, and encompasses builder competencies such as the sequencing of tasks, the use of process innovations and the choice of suppliers. Of the proportion of these risks attributed to the accuracy and reliability of the steel supply chain, perceived risks were much greater than actual risks realised.

Other findings

As well as these findings, various characteristics contributing to the performance of the construction value chain were noted. First, not one of the cases observed was finished on the original completion date, showing a remarkable tolerance for unpredictability in timeliness in construction in Australia. This tolerance extends to variations, where steel framing is considered unviable due to its unresponsive supply chain. In fact, only 'structural variations', such as adding a stairway, are more difficult with steel framing, whilst other variations that are unviable in concrete are achievable in steel.

The case studies also showed that builders create contingencies in construction budgets by up to 5 per cent of total, to allow for possible additional or unforeseen costs that cannot be recouped under a typical fixed price contract. Any difference between these contingencies and the final cost overrun effectively constitutes a 'builder's reward' over and above the imputed profit margin of 4-6 per cent (in these case studies). Interfacing between steel and other construction activities arose as an area of difficulty, and estimation does not favour innovation in construction processes or materials.

3.2.4 CONCLUSIONS

The opportunities identified in the construction value chain are founded on reducing the risk burden to the builder and releasing the contingencies held in construction budgets. The first of these opportunities is repackaging the construction process into risk-minimising components. This strategy involves placing the risk where the skills exist to best handle it (e.g. making riggers/fabricators responsible for interfacing steel columns with the slab) and may not work where dramatic variations or highly aggressive timeframes will be tolerated. Using web-enabled collaborative planning will create a more transparent information environment and aid the seamless collaboration required to reduce the builder's risk burden. Finally, the measures currently used to gauge construction performance, e.g. floor cycle time, are not always directly related to value chain outcomes. Industry-wide measurement for performance is strongly recommended to create more visibility and focus on value chain performance.

For the steel industry, a focus on creating a highly responsive supply chain for structural steel will reduce the perceived and actual risk in steel supply. In this context, the responsiveness required is the swift delivery and installation of the correct product to site where a 'structural variation' is incurred. Addressing this aspect of the supply chain will improve the overall performance of steel supply in construction.

But, why change? The issues affecting value chain performance identified in this assessment of five case studies are largely known and tolerated across the industry, at an estimated cost of up to 5 per cent of turnover (i.e. up to $3 billion of the $57 billion commercial construction industry). The true opportunity forgone in this status quo is effective process innovation and the opportunity to reallocate productive resources, at an incalculable cost to the Australian industry. Ultimately, it is up to the leaders of industry to decide in favour of transformational change.

A more extensive study, assessing a larger number and spread of buildings, is recommended to validate the findings in this report.

3.3 COSTING

By Andrew Marjoribanks
Venlaw Park Pty Ltd for The Warren Centre

3.3.1 BACKGROUND

The costing of steelwork for construction is heavily influenced by design requirements so that there can be large variations in cost between different designs for the same building, and between one building and another. Designs calling for many complicated connections, for instance, are much more expensive than those needing a minimal number of simple connections. In the current Australian construction industry environment where steelwork costing is simplistically expressed in terms of dollars per tonne, a complicated design can be as much as twice the dollar rate per tonne of a simple design, causing frustration to would-be users of steel and leading to the perception that steelwork pricing varies irrationally, and consequently the perception that using steel carries a high cost risk.

The Costing Group of the *Steel – Framing the Future* project therefore examined the factors involved in the process of costing fabricated steelwork for construction, and reviewed developments that will improve this process and lead to more cost-competitive designs and solutions in steel.

3.3.2 THE CONCRETE FACTOR

Concrete is the dominant material in the Australian construction industry, having about 87 per cent of the market. (Until two years ago it was even higher, around 95 per cent.) Consequently builders, designers and quantity surveyors have great familiarity with concrete and understand its costing very well. In addition concrete designs are less sensitive to complexity in that the main variable is formwork which can be constructed to give a variety of shapes without necessarily requiring large increases in labour costs. Concrete itself and its attendant reinforcing steel is reasonably standard in cost and the ratio of steel to concrete well understood so that cost-estimating for a project is comparatively simple. Quantity surveyors are therefore able to give reliable cost estimates at the inception of a project and even if all of the design has not been finalised, can be reasonably sure of their ground, given that whatever the final configuration happens to be, the quantity of concrete plus reinforcing is unlikely to vary dramatically. Even if it does, estimating the cost of the final design and any variations that occur is largely a calculation based on the volume of concrete plus the reinforcing. The cubic metre cost of concrete and the per tonne rate of reinforcing steel are usually fixed and the quantities can be adjusted quite readily to suit the complexity of design, or later changes to design, and formwork is usually quoted per square metre of building, allowing considerable latitude for design evolution as the project proceeds.

Formwork for post-tensioned concrete construction is not overly complex either, and reinforcing steel and cable assemblies also bear relatively fixed ratios to concrete volume for specific types of structures.

3.3.3 THE STEEL ISSUES

By contrast, steel, while it can offer clients superior cost-effective solutions in many situations, requires a construction sequence fundamentally different from concrete.

Steelwork has to be designed and the designs then translated into a format (shop detailing and shop drawings), which the fabricator can use to manufacture the elements of the structure in the factory. This process takes an amount of time, but does take place off site. When completed the components are capable of being delivered to site and immediately erected with little on-site labour.

However, engineering firms have varying levels of expertise in structural steel design, which is not surprising given the low market share of steel. It is therefore essential to engage firms with the experience and appropriate technology not only in design, but also in documentation. It is also essential to have early engagement of such firms. Steel construction requires much earlier resolution of issues such as air-conditioning ductwork layout, fixing for curtain walling and the like, and in this respect imposes a tight discipline on design and fabrication.

With the appropriate level of cost-effective design, documentation and planning, steel can be highly competitive on price and capable of speedy erection, which can be a further economic bonus. A desk study undertaken in Melbourne by Rider Hunt (Quantity Surveyors) in late 2005 for the ASI showed that for a 40m x 40m five-storey office building the price for a steel solution was between $230 and $250 per square metre as against a range of $250 to $290 for post-tensioned concrete. Also, for the recently completed 34-storey, $200 million Urban Workshop at 50 Lonsdale Street in Melbourne, a steel frame was chosen, after both concrete and steel designs had been commissioned and evaluated. Multiplex, the builder, said (2005) that steel presented less risk to the building program and a significant reduction in labour costs.

Fabricated steel work typically contains up to six cost elements:

- steel (plate, channel, beams etc) ex-mill or ex-distributor
- shop detailing
- fabrication (largely labour)
- surface treatment
- transport to site
- erection.

Very often it also includes metal decking, stud fixing and even concrete emplacement.

Of these steel itself is the least variable. The price of steel has risen in the past two or three years, but even so, usually accounts for about one-third of the cost of erected fabricated steelwork and does not vary with the complexity of the design.

Shop detailing and fabrication vary enormously in response to the intricacies or simplicity of the design, and the repetitive nature or otherwise of the building module. A paper by Watson et al (1996) indicated, from a wide spread of constructions, a range of detailing costs between $50 and $500 per tonne, and fabrication cost ranging between $200 and $2000 per tonne. The same paper also showed erection costs varying between $150 and $700 per tonne, again showing the effect of complexity.

In many instances quantity surveyors and builders apply arbitrary additions to steelwork costs and estimates. Typically, we were told, $60 per square metre is applied to cover extra cranes, penetrations and floor levelling when steel is used.

Many builders are also perplexed by what one described as “ the mystery of fire engineering” which can still cause major cost additions to steel construction if the specific regulations applying to particular constructions are not fully understood, and excessive or unnecessary fire protection applied.

It is not surprising therefore, that rates for fabricated steelwork quoted on a per tonne basis vary widely, and that a rate once established for a particular project is not transferable to another project where the design approach might be quite different. To a community of developers, architects, builders, quantity surveyors and clients accustomed to the standardised price per cubic metre of concrete, this is a major frustration, and deterrent to the adoption of steel.

Unfortunately in many projects designs are not fully complete at the time the builder takes the tender and in any event variations usually arise as the building proceeds. This is more difficult to manage with a steel structure, because the greater volume of design work and detailing needed for steel requires time, as does the purchase of steel and its fabrication. In these situations where detailed pre-planning has not been done, it is difficult to make accurate estimates of allowances needed to cover design development and also to cover variations, and this is a further frustration. One builder allows 3 per cent of tender for the design development of a concrete structure and 7 per cent for steel, when starting with an incomplete design. The extra for steel covers the extra design time needed, and the likelihood of complex connections and penetrations. This again underlines the advantage of early commitment of design effort and the resolution of issues at design stage. It also points to the fact noted in the work of Aruna Pavithran (Section 3.2) that variations are costly whether in steel or concrete, and that attention paid ahead of time to design detailing and the programming of fabrication, surface treatment delivery and erection is needed to achieve optimum performance and cost in either material.

Added to this is the understandable, but misinformed notion that if fabricated steelwork is costed by the tonne, then reducing the tonnes involved in a project will lead to a reduction in cost. As a result, a great deal of engineering creativity is devoted to reducing tonnes. This frequently leads to complexity, and the net effect is to drive the price upwards. Often a more cost-effective solution is to use simpler connections and other design elements, even if it means more steel.

3.3.4 THE WAY FORWARD

Steel offers a number of benefits to developers, builders and owners alike. To the developer there is the benefit of faster erection times and a shorter path to completion, to the builder a smaller site workforce and to the owner a high degree of flexibility to meet future changing needs. The steel community therefore needs to better articulate the relative value proposition of steel to make fabricated steelwork more accessible and less of a perceived risk to those who are attracted by these benefits. Part of the way forward will be by involving steelwork expertise from fabricators and steel designers at an early stage of the process so that the most cost-effective designs are put forward for client consideration. Another important step will be changing the costing methodology so that developers and builders can understand and rely on steelwork costing information when they set out to commit to a project.

Integral to this will be the establishment of a reliable set of regularly updated cost data covering materials, labour, design, detailing, surface protection and other cost elements so that quantity surveyors and others can rapidly assemble reliable cost estimates. Updating the data base and having it relevant for the different states and regions will be vital if it is to become authoritative and widely used. This could possibly be done through the offices of the ASI in collaboration with fabricator members.

The steel industry has already done a considerable amount in this area and has embarked on plans to improve and extend this work greatly. A major issue for the industry will be promulgating the database and overseeing its adoption.

In 1996 a major effort to identify and cost all of the elements involved in detailing, producing, surface treating and erecting fabricated steelwork culminated in the Australian Institute of Steel Construction (AISC), now the ASI, publishing the work in the form of a detailed paper by Watson et al (1996), also referred to above. This paper proposed an improved approach to costing, known as the Rational Costing Method. It contained much detail on such items as hourly rates, estimated times (and hence costs) for different connection types and different design approaches and consequently enabled much improved accuracy of costing as well as suggesting which design elements might lead to lower costs for particular functions. It was widely disseminated by the ASI although not widely adopted. Moving on from this, further work has been done including the publication in 2004 *Economical Carparks, A Design Guide* by OneSteel. This again contains detailed design and costing information of the nature that would be included in a costing database, and this publication has been extensively used in the design and construction of fabricated steelwork-based carparks.

Currently one of the important references for quantity surveyors and others is the Australian Standard Method of Measurement of Building Works (SMM) published by the Master Builders Association in conjunction with the Australian Institute of Chartered Surveyors and last updated in 1991. A draft update of Section 9, which refers to structural steel, was produced by an industry group consisting of fabricators, quantity surveyor and steel supplier (BHP Steel at the time) and co-ordinated by the AISC. This update will be an important part of the improvement of costing as it will move the industry further away from consideration of tonnage and be more enabling of elemental costing.

In further emphasis of the importance the industry places on improving the costing process attaching to fabricated steelwork, costing methodology is the focus of a separate project within an overall program funded by the Federal Government through ICIP to improve efficiency in the construction industry through the adoption of steel.

This project titled, The Development of Cost Models to Show the Relative Competitiveness of Building Systems, has been commissioned by the ASI, and is being undertaken by Rider Hunt, Quantity Surveyors, Sydney. The cost models developed will demonstrate the competitive position of steel versus concrete, and, critically, the process will create a database of cost factors that will become the foundation of a revitalised rational costing methodology. Part of the prescription for this work is that the database be capable of continuous updating, and modification for the different states and regions of Australia. This work will also lend itself to the updating of SMM, which we believe is an objective of the AIQS.

Looking further into the future, a most important outcome of the development of these cost models will be their application to 3D and Building Information Modelling (BIM). Arup (2006) foresee BIM having the ability to add information other than geometry to a 3D model including automated scheduling of quantities, supply chain integration (i.e. automating the procurement process and direct manufacture, e.g. CNC machining of metal components directly from the model). Given a reliable costing database, adding costing information to the automated scheduling of quantities would be a major step forward in improving the industry's confidence when contemplating steel solutions for construction projects.

Also to come are improvements to the whole process of fabrication and erection of steelwork. It is a manufacturing process by and large, but much of the automation and other productivity enhancing developments seen elsewhere in manufacturing industry have yet to be fully adopted by this industry. The group was very interested in a workshop held jointly by the American Institute of Steel Construction and the National Institute of Standards and Technology in 2002, and involving steel producers, fabricators, designers, erectors and construction automation experts. The stated aim was to reduce the time to complete a steel frame by 25 per cent. This was seen as necessary to maintain the competitive position of steel in the US. The workshop covered design, fabrication, erection and safety (which is a major concern in the US construction industry, as it is here), and explored the way technology, especially automation, might enable the target to be reached. The outcome was an encouraging set of pointers to possible improvements, many of which would be translatable to Australian practice.

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3.4 TECHNOLOGY

By Sandy Longworth

For The Warren Centre

3.4.1 BUILDING CONSTRUCTION DEVELOPMENT

The construction of buildings and in particular multi-storey buildings has become far more precise and dimensionally accurate over the past century.

In Section 4.5.7 Michael Gallagher outlines this construction development in the multi-storey sector. There has been a progressive introduction of prefabrication, which was typified first by the introduction of cast iron in the mid-19th century, then wrought iron and steel in the early 20th century. The past 75 years has seen a prodigious growth in pre-cast and pre-stressed concrete in the building construction sector.

Computerisation covering a wide range of applications is now firmly established in all phases of construction. This has facilitated prefabrication, not only for steel framing but for curtain walling, pre-cast concrete, service components, modularised plant rooms, electric wiring harness and internal wall modules.

There has been a gradual reduction in skilled workers and tradespeople on site with the progressive transfer of activities to improved factory production facilities. Overall worker safety improvement has been a by-product. Product sourcing is now more widely spread geographically with many specialist products manufactured overseas. This diversified activity requires dimensional accuracy, speedy data transmission, good communications and the ability to accommodate change. Material flow logistics are becoming increasingly relevant with construction in restricted CBD locations.

Component and material handling has also progressed with improvements in crane design, incorporating greater lifting capacity, increased reach, self-raising and lowering, GPS positioning and an overall reduction in operating costs in real terms.

Today's multi-storey, steel-framed buildings with modular façades are predominantly pre-fabricated and rely for efficient and rapid delivery on the introduction of technology and changes in practice that the *Steel – Framing the Future* project addresses.

3.4.2 FIRE ENGINEERING

Ben Ferguson (Section 4.5.5) provides a basic introduction to fire engineering, which is an essential building block in the *Steel – Framing the Future* project. The Building Code of Australia has been performance based since 1996, resulting in significant benefits in the case of modern fire-engineering concepts and models applied to multi-storey, steel-framed buildings.

Code provisions now cater for a wide variety of specialist buildings and construction materials. Structural fire engineering examines analytically the behaviour of structural members under specific fire conditions. It also takes into account structural redundancies enabling certain-sized steel members to be utilised in an unprotected state. There is now an increasing number of buildings constructed with unprotected steelwork, particularly with perimeter located lift access shafts.

3.4.3 FABRICATION

In recent times significant progress has been made in the development of metal fabrication methods and technology. The majority of these advances has been made by equipment manufacturers and initially adopted by capital-intensive industries such as shipbuilding, automobile manufacture and heavy engineering plant manufacture. The building construction steel fabricating industry has been slow to capitalise on much of this technology. For those fabricators who have taken up advanced technology, the rewards have more than justified the investment.

Sandy Longworth (Sections. 4.5.6, 4.5.10) summarises the range of technologies now available to industry, which includes beam lines for both rolled and fabricated sections, high-speed drilling, high-definition plasma cutting, laser/GMAW hybrid welding for multi-positional working, full-penetration butt welding and smaller high-strength fillet welds. All of these processes are eminently suited to automated fabrication, which is in keeping with 3D computer software now increasingly adopted for engineering, detailing and CNC output.

Robots have not yet found widespread favour in structural fabricating, although they have been used for placement and welding of stiffeners for plate web girders in the UK (Fairfield, UK). It is very likely, given the degree of repetition with multi-storey beam and column fabrication that robots will be introduced in due course. They are used extensively in shipbuilding, heavy equipment component fabricating and sophisticated structural connections. The Japanese Obayashi Automated Building Construction System employs automated welding of beam and column connections for multi-storey construction.

While fabricated steel prices have risen along with all other building products, the real price of fabricated structural steel has fallen (Munter, S 2006). This is primarily due to increased shop-floor productivity (work hours per tonne) which is being technology driven. There is thus scope for containing and even lowering fabricated steel costs, which should more than maintain the material's cost base against concrete.

With the growth of products from steel producers and the increasing competitiveness of overseas fabricators from China, Korea, Taiwan and India, facilitated by international detail service companies and high-speed data transfer, Australian fabricators will have to move to a higher technological level if they are to remain competitive in the medium term.

Peter Farley has contributed a very challenging paper FRAMEquick (Section 4.5.9), a world class, flexible fabricating facility with the capacity to produce beam and column units at low cost. He is proposing, in addition to fabricating long products in beam lines, the robot positioning and robot welding of fin, end, splice, base plates and miscellaneous outrigger brackets. Such a concept has the potential to impact very favourably on structural steel cost and stimulate a wider variety of composite structural design.

3.4.4 DESIGN

Emil Zyhajlo provides a 'state of the art' paper (Section 4.5.3), addressing multi-storey, steel metal deck and concrete construction, with reference to composite systems.

The Australian composite design code position is reviewed and, while the codes are by no means comprehensive by world standards, Zyhajlo concludes this is not inhibiting progress, principally because of the availability of manufacturers' design aids and supporting software. In addition there are procedures for floor vibration and fire design checking. A very reasoned plea – quoting European practice – is made for more flexibility and innovation with composite design, in particular the use of prefabricated, partially encased beams and columns. These elements, which are made off site, would be composite in load carrying and meet fire-rating requirements.

Mention is made of floor systems, covering un-propped metal deck, slim deck, pre-cast pre-stressed units and proprietary ultrafloor. The author also provides a cost ranking for various forms of columns and sees merit in steel erection columns for beam framing support, with composite concrete encasing.

3.4.5 3D DOCUMENTATION AND BIM

John Hainsworth and Stuart Bull, engineers well versed in state-of-the-art 3D, describe in their two papers the big gains to be made by adopting this technology.

Once the journey starts it will be an ongoing process, facilitated by interoperability and the progressive integration of the multitude of software packages that will ultimately comprise the Building Information Model (BIM). There will be a lowering of project risk and savings in time with software systems that can readily handle change.

Design, documentation, detailing and the transfer of concept to manufacturing format, in particular the software linkages between the team comprising engineer, detailer and fabricator, are keys to a successful steel-building project outcome. It is essential the fabricator be introduced into the team as early as possible.

Using 3D technology enables an initial model to be produced with general arrangement framing drawings and material lists, even though the finer details are still to come. At this point there is much to be gained by introducing the fabricator. Mr Hainsworth is advocating this approach, with the fabricator in the start-up group, even though the contract price may not have been settled. Collaboration is the key to performance. The fabricator will have early input and gain an understanding of the project, have an opportunity to introduce ideas and know from day one what is expected of him/her. He/she will have an opportunity to rationalise sections and establish the fabrication sequence and rate, thus enabling erectable packages to be set and dimensional sign-off dates established for transmission of data to the fabrication shop. This provides key project program milestones and sets the windows of opportunity for effecting design changes without incurring additional cost or program disruption.

Hainsworth's ideas for change have been underpinned with a meaningful survey of engineers, fabricators and detailers that has confirmed the slow and widely varying proprietary nature of 3D technology take-up (Section 5.6.3). This survey shows a minority of engineers are using 3D and the majority of this minority's software applications are not compatible with fabricators, and detailers, mainstream packages (Xsteel™, StruCad™, Prosteel™ or BoC™). Furthermore, very few engineers offer material lists at planning and estimating stage. In a similar vein, a majority of detailers has software to provide NC (numerical control) output, but only 27 per cent of fabricators surveyed have the ability to process NC data. A majority of detailers and fabricators agree that access to a consultant's model is beneficial to configuration checking.

3.4.6 DIMENSIONING

Current practice adopted by Australian engineers on steel building projects is not to provide dimensions. The fabricator/detailer has to progressively develop the information base, generating in the process requests for information and in turn time and cost. To effect a quantum change, it is suggested the engineer and detailer collaborate, or alternately the engineer assume detailing responsibility, in addition to assuming responsibility for all dimensions. This dimension discipline, along with the early appointment of the fabricator, would simplify the value chain and, when combined with JIT manufacturing and the FRAMEquick concepts of Mr Farley, would make a quantum change to the steel delivery package.

3.5 RELATIVE VALUE PROPOSITION SUMMARY

By David Ryan
Australian Steel Institute for The Warren Centre

3.5.1 OBJECTIVE

To identify the strengths and weaknesses of structural steel for use in multi-storey buildings relative to reinforced, pre-stressed or post-tensioned concrete.

3.5.2 TERMS OF REFERENCE

1. Identify perceived strengths and weaknesses of structural steel versus concrete structural solutions for multi-storey construction.
2. Test the identified perceptions with facts where possible.
3. Identify who makes the key decisions re structural form, and at what stage.
4. Identify what factors inform the decision as to structural form.
5. Identify what better information is required to better inform decision makers in future.
6. Identify the key steel solution weaknesses that can be addressed to increase the competitiveness of steel structural solutions.

3.5.3 CONCLUSIONS

The conclusions reached were as follows:

- The value proposition for steel can only be provided to the builder when a competitive design and cost is presented. The current dynamics of the industry disfavour a steel option being considered by the engineer as this represents additional cost in the process.
- Early fabricator involvement is necessary to provide a comparison cost-and-build program for steel.
- A prior fabricator relationship must be established for the builder to have confidence that the steel solution can be delivered.
- Work on the steel and fire design is necessary before the fabricator can quote as traditional engineering designs can be very conservative and not fabrication cost efficient – as a result, unnecessarily costly and non-competitive.
- Internal builders, cost figures can be significantly excessive for steel (e.g. fire spray $65/square metre ex Rawlinsons whereby a contractor was quoting $25/square metre in the Sydney market) and there needs to be a mechanism for current typical costs

to be available to builders, engineers and quantity surveyors – an ASI website is favoured.

- The decision on the framing material is made at the preliminary concept discussion time and hence the decision makers must have a representative view of cost and time for construction of the steel option at that time.
- The engineer must be convinced to have a steel option available. As this is an additional cost to his/her business there is currently little incentive for the engineer to develop a cost-effective steel alternative.
- The steel industry needs to understand and communicate where steel framing is competitive (e.g. what type of building, what span range), and define the areas of competitive advantage for steel framing.
- The building industry talks in dollars per square metre; fabricators quote dollars per tonne and do not understand what rate they need to quote to compete against concrete. The steel fabrication industry needs to understand what makes up a competitive offer and use all of the value equation aspects such as speed of construction, future proofing, lower preliminaries in setting up the value proposition to sell their offer.

3.5.4 Recommendations

1. The steel industry gears up to include and promote in its offer (as per Steel Construction New Zealand) the preliminary redesign and cost service for steel building designs in the target range. This will involve a funding of additional cost until the industry develops the necessary momentum.
2. Typical building costs are posted on the ASI website for the industry to view, plus an emailing of current costs of selected building types to structural steel decision makers, engineers, architects, quantity surveyors, estimators, builders etc.
3. The steel industry understands the value equation for steel framing and educates and informs key fabricators involved in the building market.

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