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Standardisation in Construction (CRISP)

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Standardisation and customisation in construction

**A review of recent and current industry
and research initiatives on
standardisation and customisation in
construction**

Alistair G.F. Gibb

May 2001

CRISP Consultancy Commission – 00/20

A review of recent and current industry and research initiatives on standardisation and customisation in construction

EXECUTIVE SUMMARY

Background

This report was commissioned by the Technologies and Components Task Group of the Construction Research and Innovation Strategy Panel (CRISP).

Its purpose is to identify, illustrate and where possible categorise recent and current initiatives on standardisation and customisation, particularly within UK construction.

Standardisation is the extensive use of processes or procedures, products or components, in which there is regularity, repetition and a record of successful practice. Customisation is the process of using standard components or sub-assemblies to produce a variety of end products to suit the needs of the end-user. Technical standards (e.g. ISO) are not included in this review.

Current Research

Between 1997 and 2000, almost £6.7 million has been invested by DETR and EPSRC in research projects that include standardisation and customisation in construction. Of this total figure, around £1.1 million covers general innovation which includes standardisation, with the remainder concentrating more specifically on standardisation.

The main schemes that have funded standardisation research in the UK construction sector include the EPSRC/DETR Innovative Manufacturing Initiative (Meeting Clients' Needs through Standardisation) and the DETR Partners in Innovation programme.

There is much work that claims to cover standardisation, often combined in some way with pre-assembly or general innovation. Pre-assembly research is covered in a separate report for CRISP (00/19). Many of the projects are still underway and so a full review was not possible. The appendices include summaries of the research projects, patent records and professional journal articles reviewed.

The research projects reviewed are spread across the industry sectors and involve most of the industry bodies and many universities although the main players are Salford, Loughborough and Warwick Universities and the Building Research Establishment. There appears to be little direct collaboration between projects. In some ways this is to be expected as the subject itself is very diverse. Nevertheless, further benefits should be possible by seeking to draw together the results from the various projects and to encourage the different parties to collaborate on future projects.

The deliverables from existing projects are varied in quality and format, with some focussed on dissemination to industrial end-users and others more suitable for academic audiences. Some of the more academic deliverables may be able to be developed into tool kits or other industry-focussed output. Further benefits for dissemination are possible through the EPSRC's industrial secondment scheme.

Some international work has been related to the UK situation, but this study has not included a full international review.

Motivators, facilitators, barriers and implications

Motivators, facilitators, barriers and implications include: clients and the project team; procurement methods and supply chain relationships; formal/contractual requirements; legislation; moving construction towards a manufacturing process; whole life costing, sustainability and waste reduction; people issues,

skills and training; new materials and technologies; information and communications technology; pre-assembly; and the measurement of success. There are also some sector-specific issues.

Leading repeat-order clients are at the forefront of research and implementation of standardisation, convinced that significant savings can be made. The benefits are not so obvious to one-off clients and this offers a real challenge for the future although some work is just about to start in this area. There are competing drivers within project teams, with those involved in long-term strategic relationships better able to realise the benefits. This is also true for all parties in the supply-chain where the effect of standardisation may be relatively insignificant when considered company by company, but adds considerable value when employed within an overall supply-chain strategy.

However, the cultural barriers to standardisation should not be underestimated, especially within the design professions. The most significant challenges are to combine top quality design with the principles of customised standardisation and to change the construction process into a manufacturing process without returning to the mass production of the 1950s and '60s.. The principles have been identified but they are not yet employed consistently.

Standardisation has generally led to reduced cost and improved quality, but occasionally there have been examples where the specification of a standard product has not produced these expected outcomes. The whole supply chain needs to be engaged in research to prevent this from recurring. As the supply chain develops, then better deployment of some of the standardised ICT applications and data handling methods will be required. This may occur in any case and at considerable speed, driven by commercial pressures and may not require specific research input.

Whilst there has been research on standard processes and changing the construction process to a manufacturing process, there is little direct investigation into the effect of standardisation on formal or contractual requirements or their effect on standardisation. The same is true for legislation.

Whole life costing and sustainability have been much talked about, but there is little direct research on the causal relationship with standardisation. The availability of spare parts for example is a clear driver, but there appear to have been no rigorous studies to evaluate whether such expected benefits are achieved in practice.

There is significant opportunity for human factors work on standardisation, both in evaluating the effect on *construction* workers, end-users and the general public.

The link between standardisation and innovation has been identified in principle, but more development of strategies to ensure that standardisation does not actually act as a barrier to product improvement or innovation could be beneficial.

Benefits from standardisation have been identified in much of the previous and existing work, but accurate measurement of these benefits remains elusive. Working on this further with leading repeat order clients may be possible, but overcoming the desire for headline statistics may prove difficult.

Conclusions

There is much existing research work looking at standardisation, although it is often combined with broader subjects. Furthermore, the subject is very broad and as a result projects are diverse and hard to draw together as one body of knowledge.

Much of the work is not coordinated well and benefits may be gained from further efforts in this area. Further work should be encouraged especially where it effectively engages the whole supply chain and is targeted on producing end-user guidance.

CRISP Consultancy Commission – 00/20

A review of recent and current industry and research initiatives on standardisation and customisation in construction

Contents

	PAGE
1. INTRODUCTION	
1.1. Background to this report	1
1.2. Aims and objectives	1
1.3. Report structure	1
2. STANDARDISATION	
2.1. Definitions	1
2.2. Innovation and pre-assembly	2
3. NATURE OF STANDARDISATION RESEARCH	
3.1. Primary research funding schemes	2
3.2. Review of funded research on standardisation	2
3.3. Industry research	3
3.3.1. Company specific research	3
3.3.2. Industry bodies research	3
3.3.3. Building Services Research and Information Association	3
3.3.4. Timber Research and Development Association	4
3.3.5. Steel Construction Institute	4
3.3.6. Reinforced Concrete Council	4
3.3.7. Construction Industry Research and Information Association	5
3.4. Researchers and research bodies	5
3.5. Review of deliverables from funded research on standardisation	7
4. MOTIVATORS, FACILITATORS, BARRIERS AND IMPLICATIONS	
4.1. Clients and customers	8
4.2. Project team	8
4.3. Procurement methods and supply chain relationships	8
4.4. Formal/contractual requirements	9
4.5. Legislation	9
4.6. Construction process >> manufacturing process	9
4.7. Whole life costing, sustainability and waste reduction	9
4.8. People issues, skills and training	10
4.9. New materials and technologies	10
4.10. Information and communications technology (ICT)	10

4.11.	Pre-assembly	10
4.12.	Measurement of success	11
4.13.	Sector specific motivators, facilitators, barriers and implications	11
5	BEST PRACTICE EXAMPLES	
5.1	Construction Best Practice and Movement for Innovation	12
5.2	Other publications	13
6	WORK OUTSIDE THE UK	
6.1	Summary review of international research and publications	13
7	CONCLUSIONS	14
	REFERENCES	16
	APPENDICES	
Appendix 1	CRISP reports on innovation	
Appendix 2	Summary of funded research on standardisation	
Appendix 3	Background details of EPSRC-funded research on standardisation	
Appendix 4	Background details of DETR-funded research on standardisation	
Appendix 5	Review of professional journals and magazines on standardisation	

CRISP Consultancy Commission – 00/20

A review of recent and current industry and research initiatives on standardisation and customisation in construction

1 INTRODUCTION

1.1 Background to this report

This report is the result of a commission from the Construction Research and Innovation Strategy Panel (CRISP) through their Technologies and Components Task Group. Standardisation was identified as one of the important innovations that has been the focus of industry and research initiatives in recent years.

1.2 Aims and objectives

The purpose of this report is to identify, illustrate and where possible categorise recent and current initiatives relating to standardisation and customisation, particularly directed at the UK construction sector. International and non-construction initiatives are identified where possible. However, it is important to note that this is a review of research initiatives rather than a full review of industry practice.

1.3 Report structure

First, the report defines standardisation. Then the nature of standardisation research is explained by looking at the primary research funding schemes, reviewing funded projects and their deliverables and then looking at industry commissioned research. Various motivators and barriers to the increased use of pre-assembly are then discussed along with implications and facilitators. Best practice examples are presented and work outside the UK is briefly introduced. Much of the text is supported by a series of appendices that can be found at the end of the report.

2 STANDARDISATION AND CUSTOMISATION

2.1 Definitions

Standardisation is the extensive use of processes or procedures, products or components, in which there is regularity, repetition and a record of successful practice. However, very few things are generically standard. Most countries have standards that are controlled by legislation or common practice and some of these standards are becoming internationally recognised. Clients may have standard processes or corporate badging. Suppliers produce standard items or customised items with standard components through standard procedures. Some try to deny standardisation – but without doubt it exists in all organisations and all projects. The issue is how best to manage its implementation.

This report concentrates on standardisation rather than *standards* per se (e.g. ISO or EN standards).

Customisation is a term used to describe the process of using standard components or sub-assemblies to produce a variety of end products to suit the needs of the end-user. It is a term that has been largely borrowed from the automobile industry, where different car styles are produced from a limited selection of standard parts. Furthermore, the issue of client choice is built in by allowing customised options (trim, colour, accessories etc). To a certain extent mass customisation has replaced the mid-20th Century's mass production bringing increased flexibility along with manufacturing culture benefits.

2.2 Innovation and Pre-assembly

Many of the research projects reviewed were on the subject of innovation. The main funding schemes for research are Partners in Innovation and the Innovative Manufacturing Initiative. Many of these projects include standardisation along with a number of other innovations, both in process and technology. This report concentrates on standardisation in particular and has not sought to review the broader subject of innovation. A number of CRISP reports have already been produced on this subject and these are listed in Appendix 1.

Similarly, standardisation is often linked to pre-assembly and occasionally the terms are even interchanged. However, many standard solutions do not involve pre-assembly and not all pre-assemblies are standardised. The CRISP Task Force has also commissioned a review of research initiatives in the area of pre-assembly (CRISP commission 00/19). Therefore, these issues are not specifically dealt with in this report.

3 NATURE OF STANDARDISATION RESEARCH

3.1 Primary research funding schemes

These following schemes are described in detail in the related CRISP report on pre-assembly research (00/19):

- Innovative Manufacturing Initiative (IMI)
EPSRC/DETR IMI LINK (Meeting Client's Needs through Standardisation)ⁱ
- Partners in Innovation (PII)
DETR PII programme (was PIT – Partners in Technology)ⁱⁱ
- EPSRC and other open schemesⁱⁱⁱ

3.2 Review of funded research on standardisation and customisation

Details of DETR and EPSRC funded research projects on standardisation are provided in the Appendices as follows:

Appendix 2	Summary of funded research on standardisation and customisation
Appendix 3	Background details of EPSRC-funded research on standardisation and customisation
Appendix 4	Background details of DETR-funded research on standardisation and customisation

The base data for these appendices was taken from the EPSRC and DETR websites. Then lead researchers were contacted to verify the information and provide further details.

Since 1997, almost £6.7 million has been invested by DETR and EPSRC in research projects that include standardisation and customisation in construction. Of this total figure, around £1.1 million covers general innovation which includes standardisation, with the remainder concentrating more specifically on standardisation.

Figure 1 shows that the majority of research into standardisation is of a general nature, in that it is not specifically linked to any industry sector. Mechanical and electrical services (11%), timber (6%) and cladding (5%) each have a reasonable share of the project value. Concrete, steel and brickwork then represent around 1% each. Much of the sector-specific work is led by industry bodies such as TRADA or BSRIA.

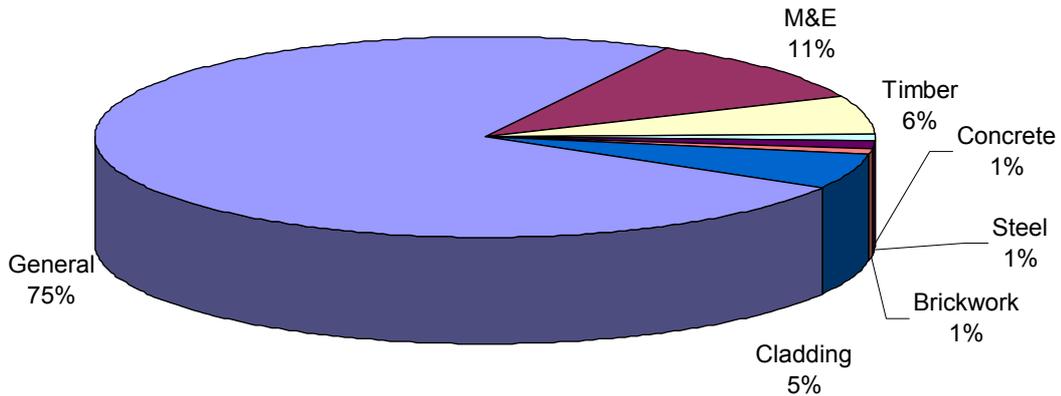


Figure 1 Industry sector breakdown for standardisation research (by value)

3.3 Industry research

3.3.1 Company specific research

It should be remembered that much of the government-funded research in this area is also funded by industry (usually 50% for Link projects and more for PII). Therefore, the funded research provides an indication of the aims and objectives of industry. However, because of the public dissemination emphasis of these projects, they only tend to cover the more general research topics. Many of them do not seem to lead to patentable exploitation.

However, there are notable exceptions to this, such as the spin-off company to be set up by Westbury as an outcome of the *market-led homebuilding as a manufacturing process* project and the *ADePT planweaver* software.

Privately funded research is hard to review in a study such as this, because many of the deliverables remain confidential. For instance, NHS Estates has completed a number of research projects on standardisation as part of their Procure 21 initiative, but the project reports are confidential and the results have only been presented in summary at public workshops.

However, companies are disseminating some of the results of their own research, often through industry fora such as the Movement for Innovation cluster groups. For example, Terrapin's M4I presentation on the labour efficiency achieved through increased standardisation of hotel modules across a number of projects.

Individual companies are undertaking research, either on their own or by private arrangements with academia or consultants. Some of this results in patentable inventions but these are hard to identify from the publicly available patent lists as to some extent all patents cover 'standard' components or processes.

3.3.2 Industry bodies research

Some industry bodies have been very successful at obtaining research funds in the area, in particular BSRIA (Building Services Research & Information Association), TRADA (Timber Research And Development Association), SCI (Steel Construction Institute) and CIRIA (Construction Industry Research and Information Association). These bodies have often been able to harness industry support on particular issues and target the specific foci of the government-funded research funding themes. The work of these industry bodies is covered in more detail in CRISP's report on pre-assembly research (00/19).

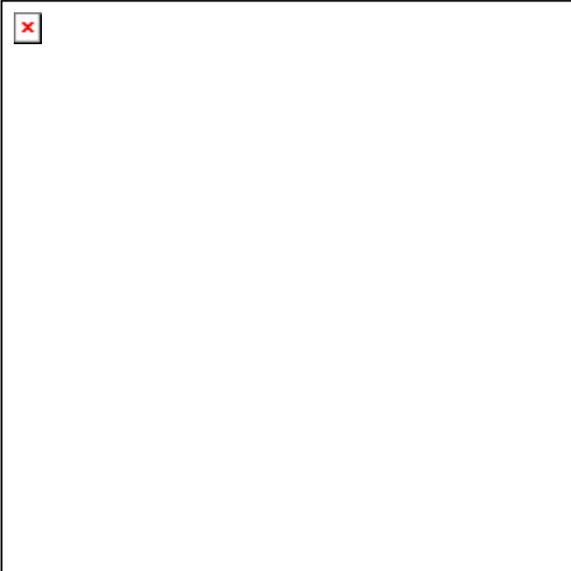
3.3.3 Building Services Research and Information Association (BSRIA)^{iv}

BSRIA is the association for building services research assisting the building services industry and its clients to improve the quality of its products and services, the efficiency of their provision and the effectiveness of their operation. Projects particularly impacting on standardisation include the following:

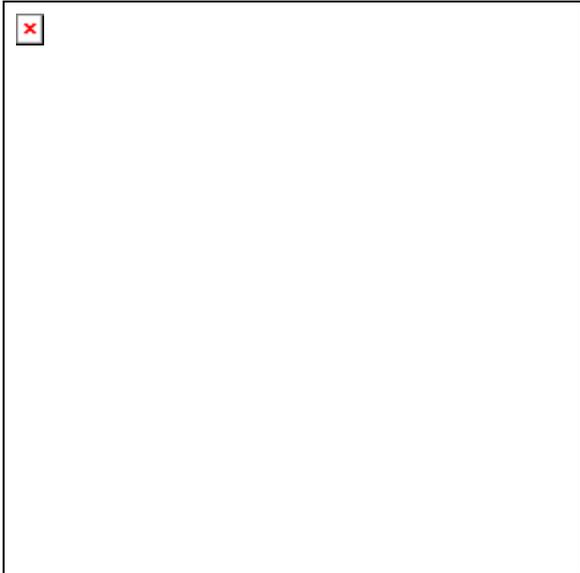
- Innovative M&E installation techniques and procedures



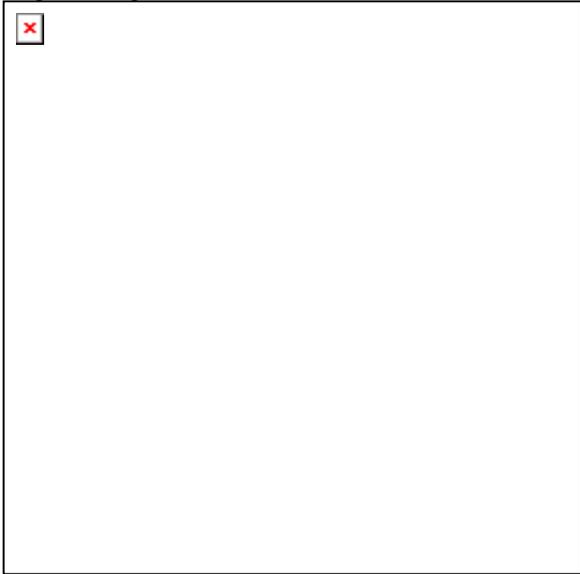
- Standard details for building services



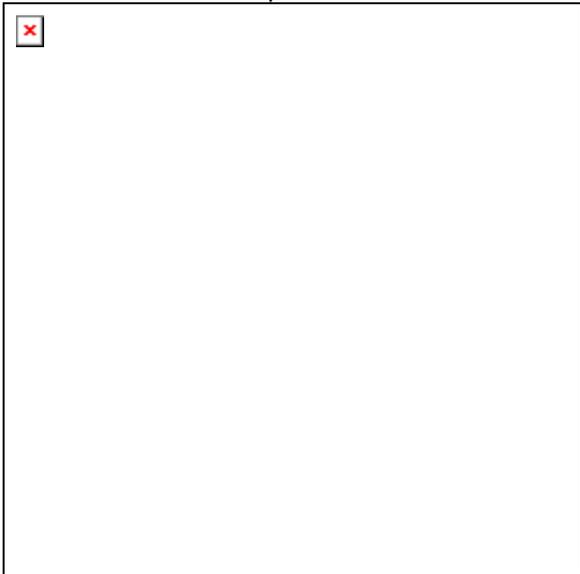
- Benchmark costs of building services installations



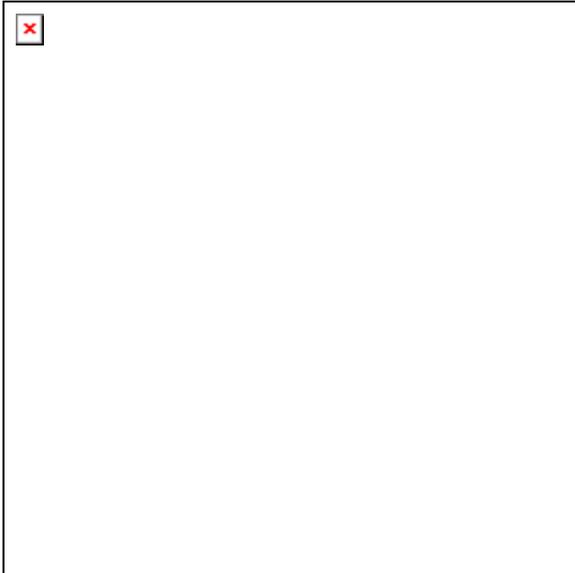
- A client guide to defining building engineering services



- Uptake of productivity improvements - demonstration of best practice cost-effective solutions



- Building services best practice initiative

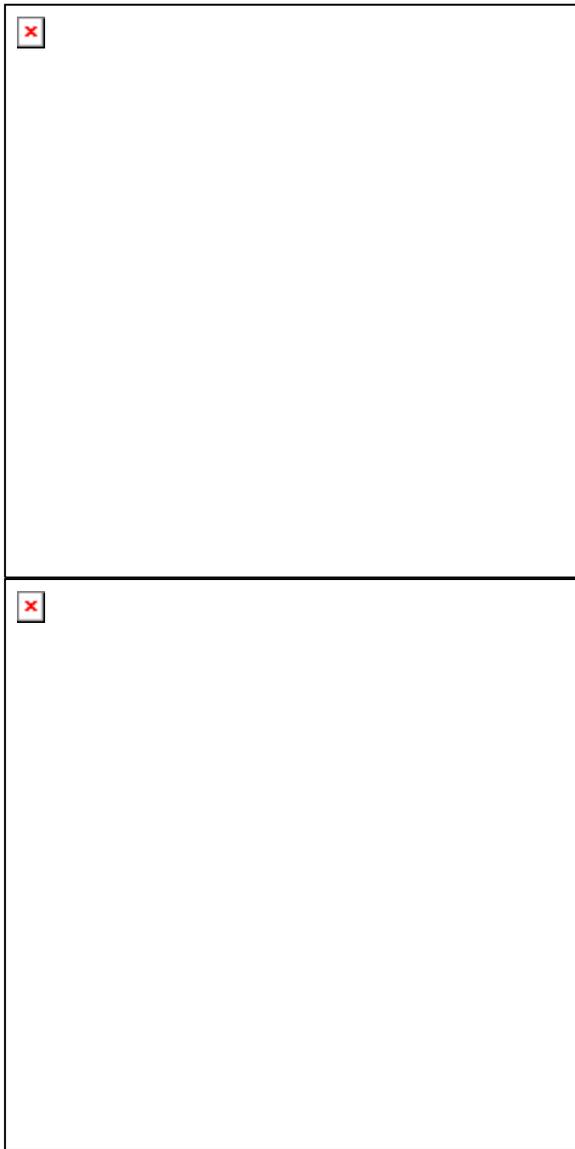


- Development of an automated productivity management tool
- Best practice clubs for innovative strategies in building services
- Building services best practice initiative
- Building services regional research task force
- Partnering toolkit: maximising the benefits with specialist contractors

BSRIA have been one of the leading organisations researching in the sector and have developed a particular approach towards measuring the success of the implementation of standardisation and other innovations.

3.3.4 Timber Research and Development Association (TRADA)^v

TRADA is a centre of excellence on the specification and use of timber and wood products. TRADA's mission is to build markets for timber and wood-based products and increase sales in the UK. TRADA maintains active programmes of research and information. Current and recently completed projects that impact on standardisation are:



Re-engineering timber frame: A

demonstration project

- The Timber Dwelling
- Shear - Extending markets for wood based panels by developing a better understanding of shear test methods and board shear properties
- Demonstrating the benefits of e-commerce to SME's in the timber supply chain
- The timber industry – implementation of recommendations to increase competitiveness
- UK timber products to improve competitiveness – a feasibility study

3.3.5 Steel Construction Institute (SCI)^{vi}

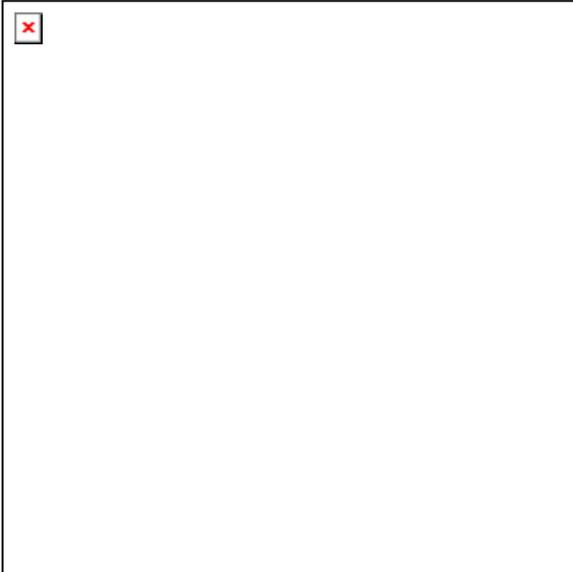
SCI is a research and technical organisation supporting the use of steel in construction. The objective of SCI is to develop and promote the effective use of steel in construction.

Publications based on standardisation research include the following:

- Steelwork design guide to BS 5950: Part 1: 1990
- Commentary on BS 5400: Part 3: 2000 - Code of Practice for the design of steel bridges [P295] *November 2000*
- Pressures for change in the construction steelwork industry - solutions and future scenarios [P293] - *February 2000*
- Specification of an integrated management system for steelwork construction fabricators - [P294] - *February 2000*

3.3.6 Reinforced Concrete Council (RCC)^{vii}

The RCC undertakes research and development in a variety of techniques and applications related to reinforced concrete frames.



One project particularly dealing with standardisation is the *Rationalised Reinforcement* project. The primary objective of this project is to reduce the costs of flat slab construction by disseminating meaningful guidance on the rationalisation of reinforcement. Within the construction industry there are many different views about what constitutes the most economic way of reinforcing concrete. This is especially true of reinforced concrete flat slabs where strict adherence to codes can give 60 reinforcement arrangements. Comparative studies were proposed to evaluate the benefits of rationalising reinforcement sizes and spacings, using bespoke prefabricated mats or fabric, and using different methods of punching shear provision. The work involved producing rationalised and prefabricated layouts of reinforcement to be used in the in-situ building of the European Concrete Building Project at Cardington, and measuring and disseminating the time/cost benefits. RCC claim that the reduction of complexity and the benefits of increased rationalisation and prefabrication will improve the quality and competitiveness of flat slabs and will have important spin-off benefits for other areas of the construction industry.

3.3.7 Construction Industry Research and Information Association (CIRIA)^{viii}

CIRIA is a UK research association concerned with improving the performance of all involved with construction and the environment. Contractors, clients, designers, regulators, financiers and government are all regularly involved in CIRIA's programme of activities.

CIRIA's work on standardisation has mainly been undertaken under their building and construction technology theme along with the following:

- building design and buildability
- building technology
- concrete and structures
- materials
- materials technology
- standardisation and pre-assembly

Further work has also been included in their process theme along with the following:

- construction management
- health and safety
- IT
- nuclear
- procurement
- productivity
- project management
- site management
- supply chain management
- Construction Productivity Network

3.4 Researchers and Research Bodies

Figure 2 shows the lead research bodies involved in funded projects in the overall standardisation and pre-assembly area. Some of these projects are just pre-assembly, some just standardisation, some both and some more general innovation projects which still have some impact on S&P. Figure 3 shows the same data but focussing just on standardisation research. The general innovation work is still included, but projects specifically dealing with pre-assembly alone have been left out. Where projects have more than one research partner, the funds have been divided between the parties (e.g. CIRIA and Loughborough). However, in-kind or secondary involvement of industry or academia is not shown.

For details of the specific projects see Appendices 2, 3 and 4. The purpose of the charts is to show the breadth of involvement in the area, both by academia and industry bodies, and to identify the lead organisations. However, because of the nature of the data, precise comparison between organisations should not be made.

One implication that can be drawn from the charts is that there is much work that is continuing largely in an uncoordinated manner. In other words the individual projects may be being managed efficiently but they may not be relating effectively to the standardisation work as a whole. There are several examples of major collaborations and of course the various networks will aid this interaction and synergy. However, it is noted that the subject itself is very broad, encompassing both process and product issues and involving many diverse stakeholders. Nevertheless, there is a strong need for more integration of research projects and their outputs.

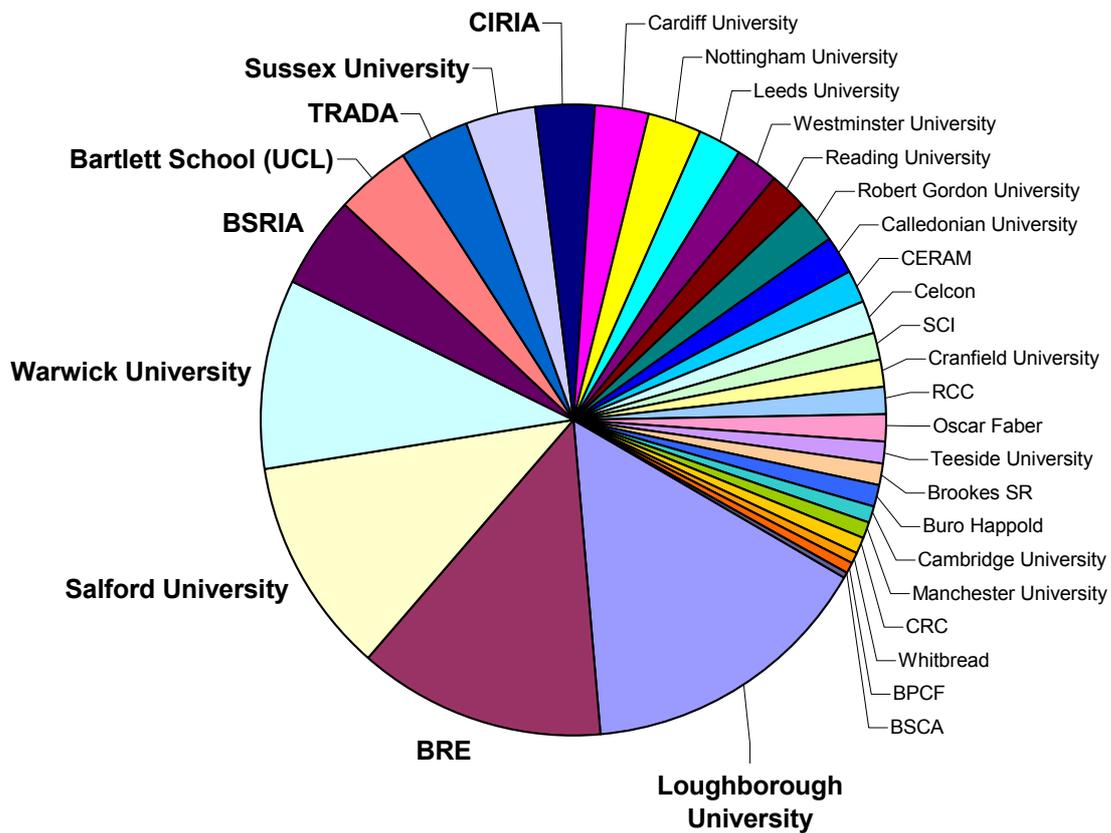


Figure 2 Researchers involved in funded projects in the standardisation and pre-assembly area (by funded value)

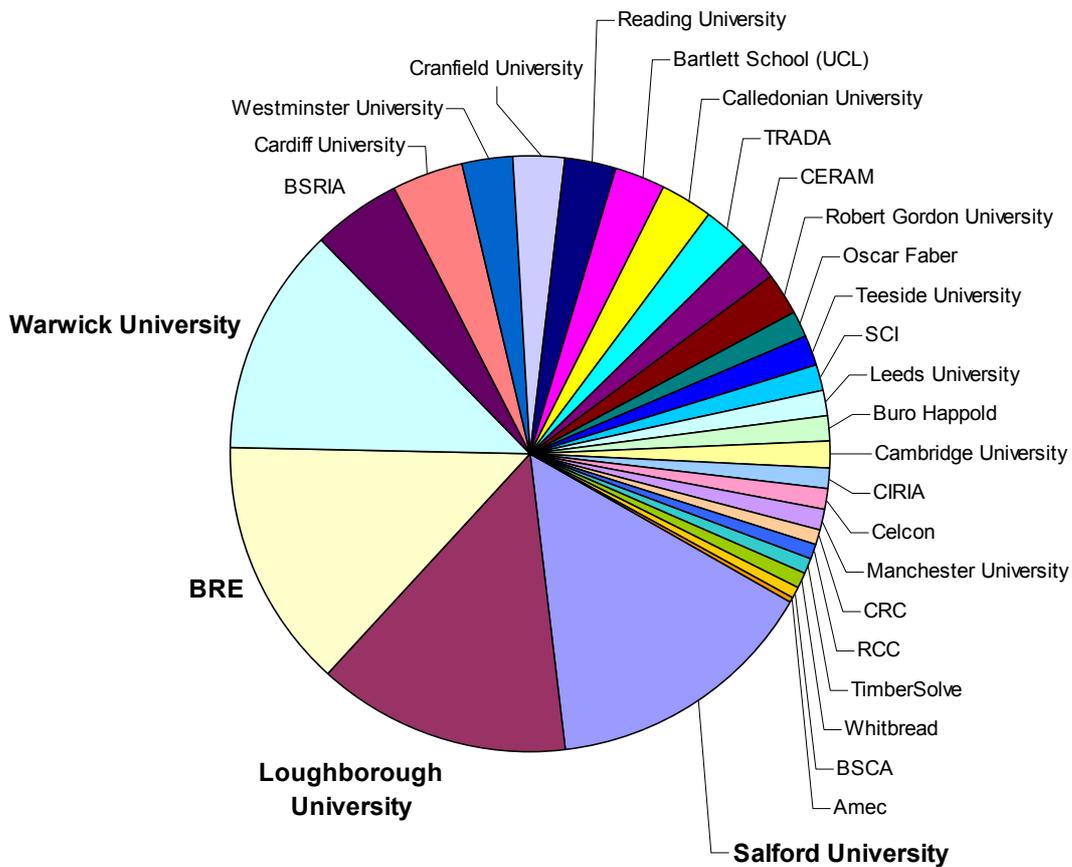


Figure 3 Researchers working on funded pre-assembly research projects

Salford University's work is mainly in the area of construction process. Loughborough have work on standard process as well as components and interfaces, particularly in the cladding sector. A particular focus is the computer integrated manufacturing work in collaboration with the University of Leeds. Some of the Loughborough work is shared with CIRIA. The Building Research Establishment (BRE) has won a considerable number of PII projects as well as some direct government funding under a framework agreement linked to their privatisation. Warwick University's projects are a series on market-led homebuilding as a manufacturing process with the latest project funded to £492k. BSRIA and TRADA are the leading industry organisations researching in the area (building services and timber respectively). There are very few individual industry companies responsible for projects. Oscar Faber, Buro Happold, Celcon and Amec are notable exceptions. However, many individual companies are involved in the projects, providing in-kind and cash support.

3.5 Review of deliverables from funded research on pre-assembly

Appendices 3 and 4 show the deliverables from the funded projects.

Many of these deliverables are of a similar format to the pre-assembly project deliverables. The various deliverables include:

- Formal word-processed reports
- Publisher-standard reports
- High-impact summary documents
- Tool kits
- Interactive CDs
- Videos (e.g. Salford's *standardised process improvement for construction enterprises (SPICE)*)
- Web-based software (e.g. *Planweaver* – developed from Loughborough and Amec's *analytical design planning technique (ADePT)*)
- Newsletters
- Websites
- Professional journal articles
- Learned journal papers
- Industry workshops and seminars
- Networks

These have been described in more detail in the related CRISP report on pre-assembly (00/19).

Where the appendix shows 'not known' for deliverables, the website has no record and the participants have failed to respond to the reviewer's contact. It should be noted that many of the projects are still underway and as such the deliverables may be limited at present.

The *ADePT* project won the 1999 Quality in Construction Innovation and Supreme award which resulted in considerable construction press interest (at least in comparison to other research projects).

The RAIS (Research Assistant Industrial Secondment) scheme is showing evidence of enhancing the dissemination in the standardisation research area. Although the take up has been poor to date, this scheme enables research assistants to be employed for a further 12 months, based with the industrial partners. One of the key aims of the RAIS scheme is to increase industrial take-up. This is often facilitated through demonstrations and workshops run by the RAIS staff, especially where the deliverable includes a tool or computer software (e.g. *Cladd:ISS* interactive CD).

There are a few projects which have clearly focussed deliverables taking the tool kit / practical guidance approach. Of particular note is the CIRIA *guide to standardisation and pre-assembly* which offers tools on opportunities, strategy and measurement. These are check-lists, decision trees and management flow-charts. Also BSRIA's output from projects like *innovative M&E installations* which has produced a series of one page data sheets covering: why you should use this system; key project details; total installed cost and installation time comparison.

There may be the opportunity to pull together some of the projects that have only taken their deliverables up to the formal report stage and produce some practical tool kit guidance. However, this would require the full co-operation of the lead researchers of the various projects. Many

academics are not very experienced at producing such focussed guidance so any efforts to this end should ensure that the deliverables really will be suitable for the needs of the industry.

4 MOTIVATORS, FACILITATORS, BARRIERS AND IMPLICATIONS

Many of the motivators, facilitators, barriers and implications of standardisation are similar to those for pre-assembly (see CRISP report 00/19 for more details). Issues relating to standardisation in particular are mentioned in this section.

4.1 Clients and customers

Clients and customers can be both motivators and barriers to the implementation of standardised processes or components. To be effective, standardisation needs to be applied as part of an overall business commitment, and maximum benefit frequently accrues in follow-on projects. Hence, it is often the repeat-order clients that seem to be leading the field. Many of the one-off clients are not able to realise the benefits, or are not willing to commit to the approach in the first place. CIRIA, working with Loughborough University has just obtained PII funding to develop their *clients guide* with a specific focus on one-off clients.

One of the main client organisations involved in standardisation research is the Construction Round Table with members such as BAA and McDonalds Restaurants. BAA have been at the forefront of process standardisation through their standard project processes. This has led to a more generic process model, the *Process Protocol* (Salford and Loughborough).

4.2 Project team

There does not seem to be much leadership in standardisation within the design organisations, in fact just the opposite. Many architects claim that any standardisation is a limit to their design freedom and will only result in boring, repetitive design, pointing to failings of previous generations for justification. Sadly, some recent standardisation applications are still insensitive and only add fuel to the designer's fire. There are some notable exceptions, but generally the RIBA and its members remain a major barrier to the increased standardisation.

4.3 Procurement methods and supply chain relationships

Procurement methods will affect the way in which the expertise in the supply chain is released to benefit the project and this is also true for standardisation. In recent years, through partnering, parts of the supply chain have been empowered and some are explaining the benefits of standardisation to enlightened clients and are showing willing to share the reduced costs and reduced risks. However, the construction supply chain is very ad-hoc and some will still sell to the highest bidder whatever the highest bidder wants. Furthermore, many projects are commissioned by occasional clients who are unlikely to be able to realise benefit from standardisation across a number of projects. Salford and Loughborough's work on *Process Protocol* is set in the context of appropriate procurement methods (ideally partnering).

In the past, the supply chain has even sometimes been a barrier to effective standardisation in that some suppliers have sought to present customised adaptations of previous projects' 'standard' products as bespoke designed 'one-off' items, apparently with the hope that they would receive a higher rate for such items. Sadly, this has tended to exacerbate the situation where perceived value and quality is often associated with uniqueness rather than with standardisation. The reality is that standard products exist in the supply chain – the issue is how to manage the process to make sure that they are exploited to the best advantage of all the stakeholders.

Several projects include consideration of supply chain issues. For example, the CIRIA projects have stressed the importance of employing procurement methods that enable early access to effective manufacturing and construction expertise and maximise the potential benefits from standardisation. Loughborough's *IMMPREST* project is measuring value as it occurs across the supply chain and identifying how project stakeholders can benefit from this added value. Also, both Salford's network

for the integration of design and construction and Cranfield's lean construction network are dealing with supply chain innovation.

Clearly, any work on standard processes must include supply chain relationships and incorporate procurement methods, so further work in this area seems inevitable.

4.4 Formal/contractual requirements

To some extent contract documents lend themselves very well to standardisation. This process-related standardisation is central to the overall effectiveness of an S&P strategy. However, there appears to have been no real work in looking at standardisation and implications on (and from) contractual relationships, except perhaps the *Process Protocol* work, by implication only. As a result, this provides a considerable opportunity for further research.

4.5 Legislation

There is no research evidence of legislation being a main driver or barrier to standardisation, especially as 'standards', such as EU or ISO standards, do not fall within the definition of standardisation used in this report. There is some anecdotal suggestion that the Building Regulations may work against innovative solutions which may include standardisation. However, the author has not been able to identify any specific evidence on this.

This subject has been considered by CRISP under the broader heading of innovation (Report 99/12 How can regulations promote construction innovation?).

4.6 Construction process >> manufacturing process

Increased standardisation must be seen within the context of an industry move from a construction process to a manufacturing process but without returning to the mass production of the 1950s and '60s. Ad hoc application of standardisation has brought some benefits but these have often been lost in the overall project review. The key manufacturing process issues include the timing of decisions and the acceptance of a 'product' standard with variables creating further products, rather than a bespoke 'build from scratch' approach.

Developing a manufacturing process is one of the priorities in the CIRIA projects and once again the various networks are covering process issues. The Warwick projects looking at *homebuilding as a manufacturing process* are seeking to develop a process engineering information system to help create such a culture, and deal effectively with product variants to support mass customisation. Warwick claim that mass customisation requires a customer to play a direct role in product design. A clear definition of the build process, effective communication of best practice and feedback are important to develop a culture for quality.

Reading's project, *transferring advanced manufacturing technology to construction* aims to apply 'design to manufacture', knowledge-based engineering technology to the construction industry's 'design to order' culture.

The IDAC (Integrating Design and Construction) funding theme has also addressed some of these issues, but despite this, there are still further opportunities for focussed work in this area.

4.7 Whole life costing, sustainability, environmental impact and waste reduction

The whole life costing implications for standardisation have not really been explored to date. The proponents of standardisation argue that the increased quality possible from using tried and tested components should also reduce the whole life cost by reducing maintenance. Furthermore, standardisation of components should reduce the variety of spares required for maintenance and thus reduce the whole life cost. One of the big draw backs of this is that historical evidence suggests that some manufacturers take advantage of having their products chosen as standards and increase the unit cost accordingly.

There should be considerable opportunities to explore whole life costing in association with standardisation. However, to do it justice would obviously require a long-term project and this would be against the current funding trend of less than three years.

Sustainability is considered by some as a driver for increased standardisation, in particular less waste resulting from standard components. Nevertheless, there has not been much research to date on this subject. The author understands that there are a number of projects in the current round of PII that seek to address such issues.

4.8 People issues, skills and training

Standardisation impacts on the people involved in its implementation, particularly in work methods, skills and training needs. Several of the projects include training packs in their deliverables. However, searching project data and reviewing deliverables confirms that people issues are not very well covered in the funded research. This actually reflects the general lack of human factors research in the engineering sector. Furthermore, some aspects of standardisation impact on the built environment and hence on the people who live, work and play in the completed buildings and facilities.

This area certainly provides an opportunity for more research.

4.9 New materials and technologies

Generally, the standardisation research and practice is not exploiting new materials or technologies. Much of the work has concentrated on increasing the applications of solutions that have been around for some time.

In fact there is a real challenge for standardisation with regard to new materials and technologies, namely, how can you standardise and yet still leave room for new techniques, approaches and materials to be used.

4.10 Information and communications technology (ICT)

Increased use of ICT is compatible with the move from a construction process to a manufacturing process. Projects involving standardisation that have specifically addressed ICT issues include:

Lboro & Leeds	CIMclad	computer integrated manufacture of cladding
Lboro & Amec	ADePT	software exploitation of design tool
Warwick	Market led homebuilding	process engineering information system to suit mass customisation
CIRIA	Adding value by S&P	improving predictability and efficiency by exploiting IT and automation
Cranfield	Decision making tools for controlled innovation	evaluation of existing IT tools
Reading	Transfer of advanced manufacturing technology	using knowledge-based engineering to enable visualisation of design alternatives

In addition to the above, many of the deliverables are utilising ICT through websites and CD outputs.

Perhaps because of the way that much of the supply chain is organised, the current applications for ICT are somewhat limited. However, this should be an area of further opportunity, but only if the supply chain moves to embrace ICT more fully.

E-commerce and other ICT-driven initiatives are starting to change the way that the construction industry works, in particular with regard to the standardised protocols that are required for it to work.

4.11 Pre-assembly

Pre-assembly is often associated with standardisation and many of the projects have incorporated both aspects. The subject is covered in the companion CRISP review of pre-assembly research (Report 00/19).

4.12 Measurement of success

Measurement of success is actually very difficult to achieve with sufficient accuracy, especially for complete projects. This has been dealt with more fully in the CRISP report on pre-assembly research (00/19).

BAA provide an example specific to standardisation, having recently completed a survey asking their framework partners how much design and pre-construction time has been saved because of the use of BAA" standard processes. The response was encouraging, with between 5 and 20% quoted for repeat projects with the same team.

4.13 Sector specific motivators and barriers

Figure 5 shows the build-type bias for research work on standardisation. More than half of the funding is for projects where the build type is not specified. Some of these projects are dealing with issues that encompass all of the construction sectors and some, especially the more general 'innovation' projects are not sector specific.

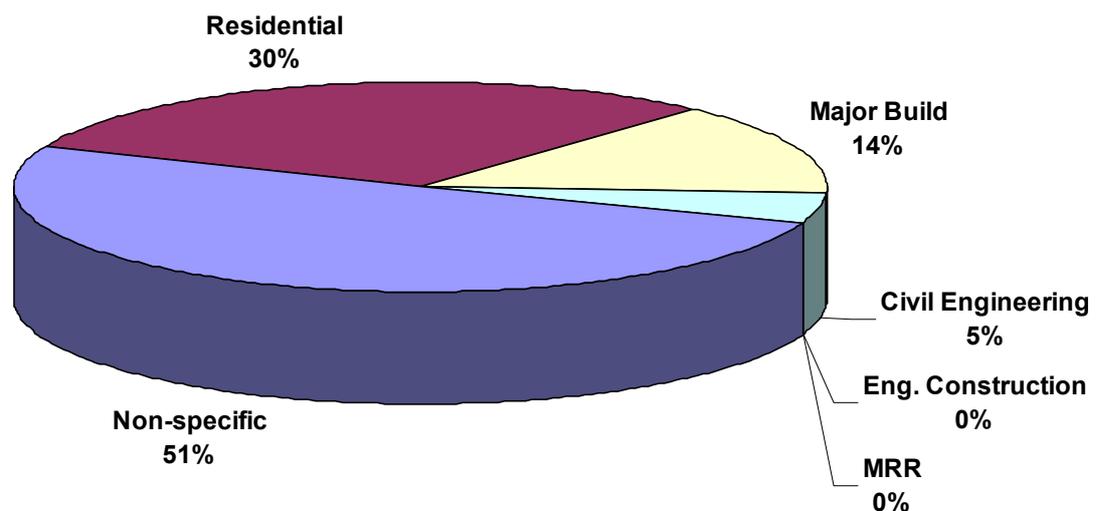


Figure 4 Build-type distribution of standardisation research (by value)

Residential construction is the second largest sector at 30%. This evidence matches the indications from professional journals that have been concentrating on residential applications over the last few years. There appears to be a clear split in the residential sector with certain organisations using modular building systems (some of which are standardised) for some of their schemes, others standard panel systems and still others concentrating only on traditional, bespoke designs. Much of the TRADA (timber) and SCI (light gauge steel frames) work has concentrated on the residential sector.

Major building represents around 14% of overall standardisation research. Much of this work relates to building services, with some cladding, some steel or concrete frames and some brickwork. There is a small amount of funded standardisation research in the civil engineering sector (5%) but none in the maintenance, repair and refurbishment (MRR) sector, nor in engineering construction (petro-chemical / power generation). These sectors may provide good opportunities for more research.

5 BEST PRACTICE EXAMPLES

5.1 Construction Best Practice Programme and Movement for Innovation

The Construction Best Practice Programme (CBPP) and the Movement for Innovation (M⁴I) are described more fully in the CRISP report on pre-assembly (00/19).

The main M⁴I thrust is demonstration projects which are published on the M⁴I website. These report 'innovative' projects, describing the project and explaining the nature of the innovation. Some are able to provide hard evidence of benefit but others, to date at least, are mainly anecdotal. Searching for standard, or standardisation identifies 27 projects:

No	Project	Nature of standardisation innovation
7	Dawlish and Sidmouth project	Combining two schemes to exploit design similarities
10	288 Bishopsgate office building	Not obvious from project data – maybe partnering and integrated team (Standard Processes)
12	Cannons Health Club - Swindon	Development and continuous improvement of a leisure building product
19	Synthetic Chemistry building	TBA
27	Gatwick South Terminal	Not obvious from project data – maybe BAA
39	International Dept Lounge Extn Lowry Centre footbridge	standard process Using several standard bridge motors in lieu of one large bespoke-designed motor – 20% saving
43	Slough: 158 Edinburgh Avenue: Meggitt	Pre-assembled cladding panels – repeated use on follow-on projects
53	Hull UWWTD Scheme	Not obvious from project data – maybe integrated project team & standard processes
56	ASDA new store	Repeatable store product to trial, improve and apply on a progressive basis
65	Maine Vapour Recover project	Not obvious from project data
66	Portsmouth & Havant WTW & SRC	Not obvious from project data
70	Highland Sewerage pfi (Inverness and Fort William)	Not obvious from project data - maybe follow-on project with same team
73	Tames/Morrison Network Partnering – South London	Not obvious from project data – maybe partnering and integrated team (Standard Processes)
87	Radius Watford	Not obvious from project data – maybe zero defect approach
94	Tonbridge Police Station	Not obvious from project data – maybe partnering (Standard Processes)
95	Thames Water Equip (West) Programme	Not obvious from project data – maybe partnering – same team on 42 projects (Standard Processes)
108	Great Notley Country Park Discovery Centre	Not obvious from project data – maybe product improvement working with supply chain
119	Luton Brache Beafeater & Travel Inn	Development of the Whitbread standard product
143	Christ Church Court	Not obvious from project data – could be steelwork
146	Mondial House	Not obvious from project data – could be M&E
160	John Harrison School	Not obvious from project data – could be process
164	Windsor Hall, University of Reading	Not obvious from project data – could be room layout
165	Christchurch Junior School replacement	Not obvious from project data
168	Harry Ramsden restaurant	Not obvious from project data – could be light steel framing
236	School works	Not obvious from project data

Most of these projects appear to be dealing with process standardisation. However, many of them, to date, have not been developed on the M⁴I website and so the exact nature of the innovation and how it relates to standardisation cannot be gauged fully. The Housing Forum also has demonstration projects, but these have not been studied in this review.

5.2 Other Publications

A number of open publications include examples of best practice. Of particular note is the following:

- Standardisation and pre-assembly – adding value to construction projects
Gibb, A G F, Groak, S, Sparksman, G & Neale R H, 1999, Construction Industry Research and Information Association (CIRIA), 6 Storey's Gate, Westminster, London SW1P 3AU. Report 176, ISBN 0 86017 498 0
14 detailed case studies and numerous abridged examples.

There is also a recent edition of Construction Management and Economics (Spon) which concentrates on related issues (April-May 2001).

Professional journals and magazines have been reviewed for the period 1998-2000 to identify examples of standardisation and these are presented in Appendix 5. The main journals that were reviewed included:

- Building
- Building Homes
- Construction News
- Building Design
- NCE (New Civil Engineer)
- ENR (Engineering News Record – USA)

Because of the non-visual and unremarkable nature of much of the aspects of standardisation there are far fewer articles than was the case for pre-assembly.

The articles fall into two main categories. Some are very terse and merely state the news item – either an application of standardisation or a change in business circumstances. Others are longer, feature articles which provide more information of the applications described. Several of these relate to data standardisation which has been a popular topic for construction journalists for several years. However, even though the quality of the reports varies widely, they do provide an indication of the type and nature of practice in the area.

6 WORK OUTSIDE THE UK

6.1 Summary review of international research and publications

Few reviewed projects addressed international aspects. *FutureConstruct* is an initiative to increase research and technological development within the European construction industries. Their report espouses lean construction, higher industrialisation including increased standardisation.

The CIRIA *adding value to construction projects* work included an international review written by David Gann of SPRU. He found that in general the factors affecting standardisation and pre-assembly are the same, irrespective of geographic location. However, he stressed that one of the issues was that standard solutions are more acceptable outside Europe and the USA. This is particularly relevant and emphasises the difficulty in applying international examples in the UK context.

There does seem to be an increased interest in standardised (and pre-assembled) domestic buildings throughout Europe. There has been a series of articles in Building Homes describing non-UK approaches to domestic construction, many of which include standardisation and other manufacturing innovations.

The Conseil Internationale de Batiment (CIB) is an international research club with a world-wide network for construction management researchers. The CIB has two working commissions that cover the area of standardisation in construction:

- open industrialisation in building
- open architecture

The *open industrialisation in building* commission has been active for many years. Its main recent publication (Sarja 1998) provides a useful commentary on various countries' applications of open industrialisation, incorporating standardisation (at a strategic level rather than at a detailed level) as well pre-assembly. Historically, the commission has been dominated by northern European precast concrete open systems building and in particular a greater acceptance of standard building solutions than has been the case in the UK. Latterly, however, this commission has become less active and may well be wound up.

The *open architecture* commission is still very active and is mainly driven by architects, concentrating mainly on residential buildings and focusing largely on standardisation and flexibility.

Japanese house building is worthy of particular mention because it has been probably the most quoted non-UK example of manufacturing techniques for construction. Much of the interest was generated following a DTI funded OSTEMS visit which resulted in a report published by CIRIA in 1994 entitled 'Innovation in Japanese prefabricated house building industries.' Although this visit was some time ago, the issues are still relevant. Gann (in CIRIA 1999) argues that the 1990's Japanese model was successful because:

- the volume of demand existed
- it delivered a high degree of choice and flexibility
- customers were demanding and prepared to pay for quality
- it produced quality products
- minimum on-site time was important

This was compared to the failure of the UK's 1960s experiment with system building which was unsuccessful because:

- the volume of demand was not forthcoming
- it was public sector (political) and not market (demand) led
- a key objective was economies of scale

Gann argues that current successful examples of standardisation and pre-assembly are closer to the Japanese 1990s model than the UK 1960s because:

- they are demand driven
- reduced cost is not the main objective
- technical solutions are available that can provide quality and do not restrict choice
- clients in the construction industry are willing to engage in constructive dialogue

7 CONCLUSIONS

7.1 Research review

Standardisation and customisation are terms that are interpreted differently by different people. As such, a review such as this is made more difficult as one has to carefully evaluate the nature of the research and how standardisation is being interpreted. For instance, there is much work on developing specific standards for materials or techniques, and also work on harmonising standards between countries, especially in the European Union. However, this *standards* work is not the focus for this review, rather, it concentrates on the extensive use of processes or procedures, products or components, in which there is regularity, repetition and a record of successful practice. Similarly, customisation is rarely found in the research as a term in itself despite many projects clearly interpreting standardisation as part of the optimisation process leading to varying levels of truly standard products or processes.

Between 1997 and 2000, almost £6.7 million has been invested by DETR and EPSRC in research projects that include standardisation and customisation in construction. Of this total figure, around £1.1 million covers general innovation which includes standardisation, with the remainder concentrating more specifically on standardisation, although some projects may have been presented in this way in order to gain better alignment with the main funding route, *meeting clients' needs through standardisation*. Much of the work is combined in some way with pre-assembly, or is included in projects with a more general innovation theme. Pre-assembly research is covered in a separate report for CRISP (00/19). Many of the projects are still underway and so a full review was not possible.

Most of the projects (75%) cover standardisation in a general sense, with mechanical and electrical services, timber and cladding sharing the bulk of the remaining projects. Concrete, steel and brickwork are only specifically covered in a few projects. There are many different universities and research organisations involved in the research, although the main players are Salford, Loughborough and Warwick Universities and the Building Research Establishment. There is little evidence of direct collaboration between projects although a number of networks and associations are starting to make some headway. However, the subject itself is very broad with many diverse stakeholders. Nevertheless, further benefits should be possible by seeking to draw together the results from the various projects and to encourage the different parties to collaborate on future projects.

The deliverables from existing projects are varied, with some being very focussed on dissemination to industrial end-users and others more suitable to academic audiences. Some of the more academic deliverables may be suitable for further development into tool kits or other industry-focussed output. The industrial secondments available through EPSRC's RAIS scheme have not been used much, but suggest further benefits for dissemination through direct involvement with industry.

7.2 Key issues

Leading repeat-order clients are at the forefront of research and implementation of standardisation, strongly believing that significant savings are to be made. The benefits are not so obvious to one-off clients and this offers a real challenge for the future although some work is just about to start in this area. There are competing drivers within project teams, with those involved in long-term strategic relationships better able to realise the benefits. This is also true for all parties in the supply-chain where the effect of standardisation may be relatively insignificant when considered company by company, but add considerable value when employed within an overall supply-chain strategy.

However, the cultural barriers to standardisation should not be underestimated, especially within the design professions. One significant challenge is to combine top quality design with the principles of customised standardisation and change the construction process into a manufacturing process and yet not return to the mass production strategies of the middle of the last century. The principles have been identified but they are not yet employed consistently.

The whole supply chain needs to be engaged in research to ensure that benefits from standardisation are realised by all the contributors. As the supply chain develops, then better deployment of some of the standardised ICT applications and data handling methods will be required. This may occur in any case, driven by commercial pressures and not require specific research input.

Whilst there has been research on standard processes and changing the construction process to a manufacturing process, there is little direct investigation into the effect of standardisation on formal or contractual requirements or their effect on standardisation. The same is true for legislation.

Whole life costing and sustainability have been much talked about, but there is little direct research on the causal relationship with standardisation. The availability of spare parts for example is a clear driver, but there appear to have been no studies to formally evaluate this benefit.

There is significant opportunity for human factors work on standardisation, both in evaluating the effect on *construction* workers, end-users and the general public.

The link between standardisation and innovation has been identified in principle, but more development of strategies to ensure that standardisation does not actually act as a barrier to product improvement or innovation could be beneficial.

Benefits from standardisation have been identified in much of the previous and existing work, but accurate measurement of these benefits remains largely elusive. Working on this further with leading repeat order clients may be possible, but overcoming the desire for headline statistics may prove difficult.

7.3 Summary

In summary, there is much existing research work looking at standardisation, although it is often combined with broader subjects. Furthermore, the subject is very broad and as a result projects are diverse and hard to draw together as one body of knowledge. Much of the work is not coordinated well and benefits may be gained from further efforts in this area. Further work should be encouraged especially where it effectively engages the whole supply chain and is targeted on producing end-user guidance.

REFERENCES

- Rowe-Roberts, A. & Hawkins, G. 2000, *Uptake of productivity improvements – Feedback from first-run studies on the Stansted Airport terminal extension project*, 19pp., Building Services Research & Information Association (BSRIA), Old Bracknell Lane West, Bracknell, Berkshire RG12 7AH.
- Sarja, A, 1998, *Open industrialisation in building*, CIB General Secretariat, Kruisplein 25G, Postbox 1837, 3000 BV Rotterdam, The Netherlands. Secretariat@cibworld.nl

END NOTES

- i Taken from the EPSRC website- www.epsrc.ac.uk/epsrcweb/index.asp
- ii Taken from the DETR PII website - www.construction.detr.gov.uk/cirm/cirmhome.htm
- iii Taken from the EPSRC website - www.epsrc.ac.uk/epsrcweb/index.asp
- iv Taken from the BSRIA website – www.bsria.co.uk
- v Taken from the TRADA website - www.trada.co.uk
- vi Taken from the SCI website - www.steel-sci.org/
- vii Taken from the RCC website - www.rcc-info.org.uk/
- viii Taken from the CIRIA website – www.ciria.org.uk

Standardisation and customisation in construction

Appendix 1

List of CRISP reports on the broader subject of innovation

Appendix 1 List of CRISP reports on the broader subject of innovation

- 98/4 Linking construction research and innovation to research and innovation in other sectors
Roger Flannagan, University of Reading
June 1999
14 pages
Technology and Performance theme group
Report available from CRISP
- 99/12 How can regulations promote construction innovation
David Gann, SPRU
October 1999
Executive
Report available from CRISP
- 99/17 Technological change: the next leap towards lean construction
Mike Townsend, Mace
January 2000
Technology & Components Task Group
Report available from CRISP
- 99/17 The contribution that technological change could make to meeting the objectives of Rethinking Construction
Neil Noble, Ove Arup & Partners
January 2000
Executive and Technology & Components Task Group
Report available from CRISP
- 00/06 Review of proceedings: Workshop - The contribution that technological change could make to meeting the objectives of Rethinking Construction
Richard Lorch Associates
July 2000
Executive and Technology & Components Task Group
Report available from CRISP

Standardisation and customisation in construction

Appendix 2

Funded research review for standardisation and customisation

Details				Funding			Type	Features											Sector			Trade/Material																					
Ref	Title	Researcher	Complete	Scheme / Programme	Cost (£K)	EPSRC	DETR	Other	Research Dissemination	Stand	Stand Comp	Non-Vol PA	Vol PA	Mod Build	Innovation	Barriers	Measurement	Best Practice	Sustainability	Time	Cost	Quality	ITC	Civ Eng	Eng Constrn	Major Build	Residential	MRR	SMEs	M&E	Timber	Steel	Concrete	Brick/Block	Cladding	Other	Non-UK						
38/6/124	A Research Technology Network	BSRIA Mike Smith	1998	PII	98	X			X						X												?		X														
38/10/39	Benefits of standardisation in steel design & fabrication	SCI D G Brown	1998	PII	25	X			X	X																X				X													
39/12/7	Building services standard solutions implemented in CAD	Oscar Faber Nick Barnard	2000	LINK MCNS	104	X			X	X												X			X			X															
M09490/01	Building services standard solutions implemented in CAD	Cambridge P M Richens	2000	LINK MCNS	86	X			X	X												X						X															
39/12/12	CIMclad: Computer integrated manufacture of cladding systems	Lboro-Leeds Anumba/Gibb/ Watson	2002	LINK MCNS	70	X			X	X					X							X																					
N12787/01	CIMclad: computer-integrated manufacture of cladding systems	Lboro-Leeds Anumba/Gibb/ Watson	2003	LINK MCNS	124	X			X	X												X																					
38/7/204	Clients' toolbox for demonstrating optimised use of standardisation & pre-assembly	CIRIA - Lboro Ann Alderson Alistair Gibb	2003	PII	117	X			X	X	X	X	X	X		X	X			X	X	X		X	X	X																	
M39190/01	COMPREST: cost model for pre-assembly and standardisation in construction	Lboro Chris Pasquire Alistair Gibb	1999	MCNS	22	X			X	X	X	X	X									X							X														
39/11/6	Decision-making tools for controlled innovation in construction	Cranfield	1998	LINK	118	X			X						X																												
38/10/57	Design guide & innovation of modular units	SCI Mark Lawson	1999	PII	25	X			X	X	X							X							X	X																	
39/11/8	Design information method & tools for detailed building design management	Amec / Lboro Murray/Austin/B aldwin	1998	LINK	42	X			X	X																																	

Details				Funding			Type	Features											Sector					Trade/Material																	
Ref	Title	Researcher	Complete	Scheme / Programme	Cost (£K)	EPSRC	DETR	Other	Research	Dissemination	Stand	Stand Comp	Non-Vol PA	Vol PA	Mod Build	Innovation	Barriers	Measurement	Best Practice	Sustainability	Time	Cost	Quality	ITC	Civ Eng	Eng Consin	Major Build	Residential	MRR	SMEs	M&E	Timber	Steel	Concrete	Brick/Block	Cladding	Other	Non-UK			
38/6/92	Innovation & strategy: the link for building services	BSRIA Anne King	1998	PII	23	X			X							X										X															
M42107/01	Innovation in small construction firms	Salford Peter Barrett	2001	??	59	X			X							X													X												
M42114/01	Innovation in small construction firms	Manchester M Miozzo	2001	??	69	X			X							X												X													
39/12/6	Innovation in standardised component systems in housing	Sussex James Barlow	2001	LINK MCNS	308	X			X		X					X											X														
M06321/01	Innovation in standardised component systems in housing	Cardiff M M Naim	2001	??	249	X			X		X					X											X														
38/8/116	Innovative components from UK timber resources	TRADA Martin Milner	1999	PII	81	X			X	X	X					X																									
38/6/171	Innovative M&E Installation	BSRIA Mike Smith	2000	PII	83	X			X							X	X											X													
SCI9916	Innovative Steel-Timber Composite Components for Residential Buildings	SCI	PII	??	45	X			X		X					X																									
L39230/01	International benchmarking for value, integration and standardisation : Britain and France compared	Bartlett Winch	1999	??	117	X			X		X	?																													X
39/3/538	Key industry publications promoting standardisation of constructional steelwork	BSCA Chris Bowser	2000	PII	24	X			X		X								X							X															
39/11/3	Managing the brief as a process of innovation	Salford Peter Barrett	1997	LINK IDAC	62	X			X		X					X																									

Details				Funding			Type	Features													Sector					Trade/Material																
Ref	Title	Researcher	Complete	Scheme / Programme	Cost (£K)	EPSRC	DETR	Other	Research	Dissemination	Stand	Stand Comp	Non-Vol PA	Vol PA	Mod Build	Innovation	Barriers	Measurement	Best Practice	Sustainability	Time	Cost	Quality	ITC	Civ Eng	Eng Constr	Major Build	Residential	MRR	SMEs	M&E	Timber	Steel	Concrete	Brick/Block	Cladding	Other	Non-UK				
L99555/01	Market-led homebuilding as a manufacturing process - TTS	Warwick R Roy	1999	??	60	X			X	X	X	X	X	X	X	X												X	X													
M21942/01	Market-led homebuilding as a manufacturing process- phase II	Warwick R Roy	2001	??	492	X			X	X	X	X	X	X	X	X											X	X														
K66963/01	Market-led homebuilding as a manufacturing process: IMI	Warwick R Roy	1998	IMI	262	X			X	X	X	X	X	X	X	X											X	X														
R19984/01	Network for the integration of design and construction to foster innovation in the construction industry supply chain	Salford Powell/Lenard	2002	??	62	X			X							X													X													
N01262/01	Network on information standardisation & exchanges in construction	Salford Aouad/Cooper/ Alshawi/Sun	2003	??	63	X			X	X																																
M44415/01	Network on lean construction	Cranfield Rogerson	2001	??	62	X			X							X																										
38/7/154	Optimised use of standardisation, preassembly & modularisation in construction	CIRIA - Lboro - Laing Staynes/ Gibb/Spksmn	2000	PII	58	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X													
36/8/200	Overcoming barriers to standardised wiring systems	BRE A K R Bromley	2001	BRE frame	118	X			X		X															X	?			X												
M86392/01	Overcoming client & market resistance to pre-fabrication & standardisation in housing	Robert Gordon Edge/Polllock/ Al-Hajj/Slaven	2002	??	142	X			X	X	X	X	X	X	X	X	X										X															
39/3/452	Rationalisation in standardised construction	Whitbread Nigel Graham	Term 2000	PII	54	X			X		X			X												X																
39/3/284	Rationalisation of flat slab reinforcement	RCC Charles Goodchild	2000	PII	60	X			X		X	X														X																

Details				Funding			Type	Features													Sector					Trade/Material															
Ref	Title	Researcher	Complete	Scheme / Programme	Cost (£K)	EPSRC	DETR	Other	Research	Dissemination	Stand	Stand Comp	Non-Vol PA	Vol PA	Mod Build	Innovation	Barriers	Measurement	Best Practice	Sustainability	Time	Cost	Quality	ITC	Civ Eng	Eng Consin	Major Build	Residential	MRR	SMEs	M&E	Timber	Steel	Concrete	Brick/Block	Cladding	Other	Non-UK			
36/8/34	Research in support of standardisation on fire resistance	BRE Bill Morris	2000	BRE frame	316	X			X		X																														
38/6/169	Standard Details for Building Services	BSRIA Mike Smith	2000	PII	82	X			X		X															X					X										
38/7/197	Standard risk register for the construction supply chain	CIRIA David Churcher	2000	PII	81	X			X		X																														
39/12/8	Standardisation & skills: a transnational study of skills, education & training for prefabrication in housing	Westminster Clarke/Gould	2000	LINK MCNS	86	X			X		X	X	X														X														
M46006/01	Standardisation & skills: a transnational study skills education & training for prefabrication in housing	Westminster Clarke/Gould	2000	LINK MCNS	97	X			X		X	X	X														X													X	
M10915/01	Standardisation in brick work construction	Teeside Hobbs/ Dawood	2001	LINK MCNS	82	X			X		X	X																													
39/12/5	Standardisation in brickwork construction	Teeside Hobbs/ Dawood	2001	LINK MCNS	15	X			X		X																														
38/19/188	Standardisation of datasets for building life cycle energy & environmental modelling	BRE David Bloomfield	2000	PII	43	X			X		X													X							X										
39/12/2	Standardisation of window & cladding interfaces (Cladd:ISS)	Lboro Alistair Gibb	2000	LINK MCNS	68	X					X	X							X																						
M97220/01	Standardisation of Window & Cladding Interfaces (Cladd:ISS) (RAIS 1)	Lboro Alistair Gibb	2001	RAIS	24	X			X		X	X																													
R16389/01	Standardisation of Window & Cladding Interfaces (Cladd:ISS) (RAIS 2)	Lboro Alistair Gibb	2001	RAIS	22	X			X		X	X																													

Details				Funding			Type	Features													Sector						Trade/Material														
Ref	Title	Researcher	Complete	Scheme / Programme	Cost (£K)	EPSRC	DETR	Other	Research	Dissemination	Stand	Stand Comp	Non-Vol PA	Vol PA	Mod Build	Innovation	Barriers	Measurement	Best Practice	Sustainability	Time	Cost	Quality	ITC	Civ Eng	Eng Constr	Major Build	Residential	MRR	SMEs	M&E	Timber	Steel	Concrete	Brick/Block	Cladding	Other	Non-UK			
38/6/181	Update of BMS standard specification	BSRIA Mike Smith	2001	PII	35	X			X		X																														
38/6/161	Uptake of productivity improvements	BSRIA Rowe-Roberts/ Hawkins	2000	??			X		X			X	X	X		X		X	X		X	X	X				X					X									

Standardisation and customisation in construction

Appendix 3

EPSRC-funded projects on standardisation and customisation

**EPSRC-funded projects on standardisation
Abstract, Outputs & Deliverables, Investigator details**

<p>GR/K66703/01 <i>Development of a generic design and construction process protocol</i> Abstract: see GR/M20006/01 Outputs and Deliverables: see GR/M20006/01</p>	<p><i>Investigator Details:</i> A.J. Hinks Salford University <i>Investigator Details:</i> Professor G Aouad Salford University Construction & Property Man (Res Cen) 0161 295 5176 Fax: 0161 295 5011 g.aouad@salford.ac.uk <i>Investigator Details:</i> Professor R Cooper Salford University Art & Design (Res Cen) 0161-2956146 Fax: 0161-2956174 r.cooper@salford.ac.uk</p>
<p>GR/K66963/01 <i>IMI: market-led homebuilding as a manufacturing process</i> Abstract: see GR/M21942/01 Outputs and Deliverables: see GR/M21942/01</p>	<p><i>Investigator Details:</i> Mr R Roy Warwick University Sch of Engineering 024 76523968 Fax: 01203 524307 roy.r@eeyore.wmg.warwick.ac.uk <i>Investigator Details:</i> Jones, S. P. Cardiff University Welsh School of Architecture 029 2087 4078 Fax: 029 2087 1625 jonesp@cf.ac.uk <i>Investigator Details:</i> Mr W Forster Cardiff University Welsh School of Architecture 029 20874000 Fax: forsterw@cardiff.ac.uk</p>

<p>GR/L39179/01 <i>Standardisation of window and cladding interfaces (Cladd:ISS)</i> Abstract: Interfaces between elements of buildings of the work of different trades, particularly complex aspects such as cladding, generate problems throughout the construction process. Effective interface management, including appropriate standardisation of processes and details, will increase value for money for clients, reduce costs and shorten project durations. This research will facilitate cultural change in the cladding industry by better management of the design development process particularly regarding construction interfaces. This will be achieved through best practice guides covering both the process and technical aspects of window and cladding interfaces, particularly for off the shelf systems. A) Process - strengthening the links between scope and detailed design, fabrication and installation by standardising the interface management process, by producing a strategy for improvement, benchmarking best practice for procurement routes, contractual arrangements, performance testing, design development, tolerances, warranties and interface responsibility. B) Technical - collating appropriate standardised, technical details for interfaces emphasising buildability and life cycle maintenance; developing a strategy for standardisation. Outputs & Deliverables: Cladd:ISS CD available from CWCT, Bath Implementation workshops running 2001 Various journal, conference and magazine papers published</p>	<p><i>Investigator Details:</i> Alistair Gibb Loughborough University Civil & Building Engineering 01509 223097 Fax: 01509 223981 a.g.gibb@lboro.ac.uk http://www-staff.lboro.ac.uk/~cvagg/</p>
<p>GR/L39230/01 <i>International benchmarking for value, integration and standardisation : Britain and France compared</i> Abstract: Benchmarking against excellent competitors is central to the business reengineering process. The research proposed here provides an innovative programme of benchmarking against one of the world's leading construction industries. Evaluating the strengths and weaknesses of a different manner of organising the construction process fits clearly within the CMP programme objectives and provides an important demonstration to facilitate learning within the UK industry. This benchmarking programme will focus upon three specific areas - the enhancement of value for the client; the integration of design and construction; the standardisation of systems for structural elements; and, through the demonstration effect, help to generate a culture for improvement both within the collaborating companies and more broadly. Outputs and Deliverables: 2 Journal Papers – Construction Management & Economics 3 reports available from Bartlett School – 7: Project performance in Britain & France (Euroscan) – 8: Mapping the construction process in Britain & France – 9: Measuring on-site performance in Britain & France (CALIBRE).</p>	<p><i>Investigator Details:</i> Dr GM Winch University College London Bartlett Sch of Architecture & Planning 020 76 79 59 21 Fax: 020 79 16 18 87 g.winch@ucl.ac.uk</p>
<p>GR/L99555/01 <i>TTS: market-led homebuilding as a manufacturing process</i> Abstract: see GR/M21942/01 Outputs and Deliverables: see GR/M21942/01</p>	<p><i>Investigator Details:</i> Mr R Roy Warwick University Sch of Engineering 024 76523968 Fax: 01203 524307 roy.r@eeyore.wmg.warwick.ac.uk</p>

<p>GR/M06321/01 <i>Innovation in standardised component systems in housing</i> Abstract: No abstract available Outputs and Deliverables: Unknown</p>	<p><i>Investigator Details:</i> Dr MM Naim Cardiff University Maritime Studies & International Trans 029 20874271 Fax: 029 20874301 naimmm@cf.ac.uk</p>
<p>GR/M09490/01 <i>Building services standard solutions implemented in CAD</i> Abstract: Standardisation is widely recognised as a key element in reducing design time, cutting construction costs and ensuring efficient design solutions. Most buildings, because of their unique site and usage requirements are in effect prototypes where standardisation may be difficult to implement. Plant rooms and their associated risers and ceiling ductwork, however, are an important exception. Their components are drawn from a (relatively) fixed range of alternatives, and there are definite relationships and interactions between their components and systems. In this sense the three-dimensional spatial layout of these services is governed by a set of more or less well understood rules. Implementing these rules and other information relating to design, construction operation and maintenance in CAD will facilitate both data capture/re-use and enable solutions to be readily customised to suit particular constraints (eg moulded to suit spatial constraints). Plant rooms and services thus lend themselves to standardisation, and they are highly appropriate as a research topic under the Meeting Client Needs through Standardisation Programme, operated under the LINK Scheme. Outputs and Deliverables: Unknown</p>	<p><i>Investigator Details:</i> Mr PM Richens Cambridge University Architecture Telephone: 01223 331709 Fax: pnr12@cam.ac.uk</p> <p><i>Investigator Details:</i> Nick Barnard Oscar Faber Nib@faber-e.oscarfaber.co.uk</p>
<p>GR/M10915/01 <i>Standardisation of brick work construction</i> Abstract: The project aim is to retain the flexibility and the aesthetic durability advantages of traditional brickwork, whilst increasing speed, reliability and efficiency of the construction process, resulting in the enhanced cost effective quality of the finished work. A single solution to standardisation is unlikely to be suitable for the whole range of brickwork schemes and two basic approaches to the incorporation of standardisation are being investigated. The objectives will develop proposals for: -</p> <ul style="list-style-type: none"> • On-site construction- Standardised details and construction procedures. • Prefabrication- Design, manufacturing, transportation, jointing and erection procedures. <p>Underlying both of the areas will be a study of improved approaches to the materials specification, handling and storage, quality assurance and supply chain management. Outputs and Deliverables: Website http://sst.tees.ac.uk/mcns-brickwork/ Various conference papers: Venice 1999, ARCOM 99, IBMAC Madrid 2000, IStructE 2000.</p>	<p><i>Investigator Details:</i> Professor B Hobbs Teesside University School of Science & Technology Telephone: 01642 384408 Fax: 01642 384411 B.Hobbs@tees.ac.uk</p> <p><i>Investigator Details:</i> Professor N Dawood Teesside University School of Science & Technology Telephone: 01642 342410 Fax: 01642 342401 n.n.dawood@tees.ac.uk</p>

<p>GR/M20006/01 <i>The Process Protocol - level two</i> Abstract: Project incollaboration with Loughborough University (GR/M21539/01). This programme of work builds on work done on an earlier grant to develop a high level process map for design and construction. The programme will take the eight sub levels of the process (Development Management, Project Management, Design Management, Resource Management, Production Management, Health Safety Legal and Statutory management, Facilities Management and Process Management) and develop sub-process maps with multi-media support. These maps will result from a programme of research which will include identification of trends in new product development process management in manufacturing industry, workshops, scenario building and process mapping with the industry collaborators. The resulting processes will be implemented on a construction project. In addition research will be undertaken to identify trends in IT tools to support improved process in construction, resulting in supporting guidelines to the process maps.</p> <p>Outputs and Deliverables: Various deliverables from the first Process Protocol project – Process maps – incl 4 page high impact publicity document Website http://pp2.dct.salford.ac.uk/ Several journal & conference papers – details on website</p>	<p><i>Investigator Details:</i> Professor R Cooper Salford University Art & Design (Res Cen) 0161-2956146 Fax: 0161-2956174 r.cooper@salford.ac.uk <i>Investigator Details:</i> Professor G Aouad Salford University Construction & Property Man (Res Cen) 0161 295 5176 Fax: 0161 295 5011 g.aouad@salford.ac.uk</p>
<p>GR/M21539/01 <i>The Process Protocol - level two</i> Abstract: Project in collaboration with Salford University (GR/M20006/01). This programme of work builds on work done on an earlier grant to develop a high level process map for design and construction. The programme will take the eight sub levels of the process (Development Management, Project Management, Design Management, Resource Management, Production Management, Health Safety Legal and Statutory management, Facilities Management and Process Management) and develop sub-process maps with multi-media support. These maps will result from a programme of research which will include identification of trends in new product development process management in manufacturing industry, workshops, scenario building and process mapping with the industry collaborators. The resulting processes will be implemented on a construction project. In addition research will be undertaken to identify trends in IT tools to support improved process in construction, resulting in supporting guidelines to the process maps.</p> <p>Outputs and Deliverables: Various deliverables from the first Process Protocol project – Process maps – incl 4 page high impact publicity document Website http://pp2.dct.salford.ac.uk/ Several journal & conference papers – details on website</p>	<p><i>Investigator Details:</i> Professor A Thorpe Loughborough University Civil & Building Engineering 01509 222631 Fax: 01509 223981 a.thorpe@lboro.ac.uk <i>Investigator Details:</i> Professor SA Austin Loughborough University Civil & Building Engineering 01509 222608 Fax: 01509 223981 s.a.austin@lboro.ac.uk <i>Investigator Details:</i> Dr AN Baldwin Loughborough University Civil & Building Engineering 01509 222605 Fax: 01509 610231 a.n.baldwin@lboro.ac.uk</p>

<p>GR/M21942/01 <i>Market-led homebuilding as a manufacturing process- phase II</i> Abstract: The house building industry has been slow to adopt new working practices essential for product quality and customer focused operations. The proposal is aimed at four areas to support a move towards a mass customisation industry and improvements in product quality. Rapid product configuration to customer specification and consistency of the build process will require an increasing use of pre-fabricated parts, and the first project will study the connectivity of various build technologies and customisation options they provide. The supply lead times for fixtures and fittings will also need to be reduced and just-in-time principles adopted for effective materials control; the second project will formulate policies for a supplier development programme, and study the implementation process. Mass customisation requires a customer to play a direct role in product design, and the third project will research and develop a product configuration and visualisation customer interface for the new order fulfilment process. A clear definition of the build process, effective communication of best practice and feedback are important to develop a culture for quality; the fourth project will research and develop a process engineering information system to help create such a culture, and deal effectively with product variants to support mass customisation.</p> <p>Outputs and Deliverables: Spin-off company wholly owned by lead partner Westbury Various papers including CME journal 1999, Development of a customer focused strategy in speculative house building and ARCOM conference 1999, Liverpool</p>	<p><i>Investigator Details:</i> Mr R Roy Warwick University Sch of Engineering 024 76523968 Fax: 01203 524307 roy.r@eeyore.wmg.warwick.ac.uk</p>
<p>GR/M39190/01 <i>COMPREST: cost model for pre-assembly and standardisation in construction (Pilot study)</i> Abstract: Short pilot study project to test the concept of a cost model for standardisation and pre-assembly – concentrating on mechanical services for major buildings. COMPREST led to the IMPREST project GR/N34000/01. The pilot study investigated the data currently available for measuring the cost implications of standardisation and pre-assembly, and identified that some data related to easily identifiable costs such as resources and site costs; and that these costs can be measured using traditional QS/estimating techniques. However, it was clear from the pilot study that these costs were only part of any benefit evaluation exercise. Several others costs were incurred, but were either included in existing accounting systems, were unidentifiable individually, or were not accounted for at all.</p> <p>Outputs and Deliverables: Website – http://www.lboro.ac.uk/research/immprest/proj.htm Journal paper, Building Research & Information, in press - Various other presentations</p>	<p><i>Investigator Details:</i> Dr CL Pasquire Loughborough University Civil & Building Engineering 01509 222895 Fax: 01509 223981 c.l.pasquire@lboro.ac.uk</p> <p><i>Investigator Details:</i> Alistair Gibb Loughborough University Civil & Building Engineering 01509 223097 Fax: 01509 223981 a.g.gibb@lboro.ac.uk http://www-staff.lboro.ac.uk/~cvagg/</p>

<p>GR/M42107/01 <i>Innovation in small construction firms</i> Abstract: The project will bring together eight SMEs to work collectively towards the above objectives. They will be introduced to: two large construction firms who are exponents of successful innovation; leading international practice from Scandinavia; and they will work with an experienced group of academics with specialist knowledge of innovation. Within this very stimulating environment the main thrust of the project will be to: Assess the current state of innovation management within the construction SMEs through an audit of the business and organisational drivers of innovation. This will be linked to examples of innovation within the firms. Based on the above understanding, work with the SMEs closely in an action research mode to develop best practice in creating and supporting innovation. The project will deliver a good practice guide giving senior managers in construction SMEs a clear vision of the importance of innovation and effective innovation management, so that they can effectively lead the development of an ongoing capacity to innovate successfully. The guide will also provide practical examples so that, at an operational level, effective innovations can be designed. Outputs and Deliverables: Project still underway – several conference papers (CIB W65, Reading 2000; AEC 2001; ARCOM 2001)</p>	<p><i>Investigator Details:</i> Professor PS Barrett Salford University Construction & Property Man (Res Cen) 0161 2955588 Fax: 0161 2953862 p.s.barrett@surveying.salford.ac.uk</p>
<p>GR/M42114/01 <i>Innovation in small construction firms</i> Abstract: The project will bring together eight SMEs to work collectively towards the above objectives. They will be introduced to: two large construction firms who are exponents of successful innovation; leading international practice from Scandinavia; and they will work with an experienced group of academics with specialist knowledge of innovation. Within this very stimulating environment the main thrust of the project will be to: Assess the current state of innovation management within the construction SMEs through an audit of the business and organisational drivers of innovation. This will be linked to examples of innovation within the firms. Based on the above understanding, work with the SMEs closely in an action research mode to develop best practice in creating and supporting innovation. The project will deliver a good practice guide giving senior managers in construction SMEs a clear vision of the importance of innovation and effective innovation management, so that they can effectively lead the development of an ongoing capacity to innovate successfully. The guide will also provide practical examples so that, at an operational level, effective innovations can be designed. Outputs and Deliverables: Journal paper – Technology Analysis & Strategic Management – Restructuring in the British Construction Industry</p>	<p><i>Investigator Details:</i> Dr M Miozzo UMIST Manchester School of Management</p>

GR/M44415/01

Network on lean construction

Abstract:

Set up a UK based network to develop and progress the theme of 'lean construction' by joint university/industry research projects as one route to improving the efficiency of the construction processes and provide added value to clients. This is in accordance with industry aims and IMI "Construction as a Manufacturing Process" Programme. The initial network links one university (Cranfield) with specific expertise in manufacturing and some knowledge of construction management with leading universities concerned with construction management issues (Salford, Reading, Loughborough, Dundee) and a university (bath) with expertise in both manufacturing and construction, as well as architects, contractors, consulting engineers and the national research institution (BRE). A major activity will be a series of specialist interactive workshops leading to the development and publication of a series of interpretative reports. These reports will be available for wider dissemination but their main purpose will be to define areas where there are knowledge gaps in the application of 'lean' concepts to construction so that network members can develop collaborative research programmes and provide input to policy development in this area.

Outputs and Deliverables:

Website http://www.cranfield.ac.uk/sims/quality/lean_con.html

Current, on-going network

4 position papers published:

- Integrated Envelopes to Structures and Buildings
- Supply Network Research Map
- The 'Value Through Design' Project
- Whole Life Integrated Process Including Communication Management

Investigator Details:

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GR/M46006/01

Standardisation & skills: a transnational study skills education & training for prefabrication in housing

Abstract:

The objective of the research is to assess how far the extension of manufacturing-based methods in the British construction industry is deterred by existing skill and education/training structures and to suggest areas for improvement. It will: identify different forms of prefabrication and standardisation associated with different skill constellations in Britain, Denmark, Germany and The Netherlands; describe the skills (including the design of multi-skilling), qualifications and training of all the different participants in more traditional housing construction compared with those for non-traditional forms of construction; outline the related business processes (including client/contractor/subcontractor relations) and supply chains (from design to manufacturing to assembly) and firm/project organisation. The focus is on a selection of housing association projects and a survey will be conducted of the housing associations, designers, contractors, subcontractors and operatives concerned. The project is for two years and its output is a research report/book, articles, handbooks and a summary booklet for wide dissemination through a conference, seminars and publications.

Outputs and Deliverables:

Unknown

Investigator Details:

Dr LM Clarke
Westminster University
Westminster Business School

:

<p>GR/M86392/01 <i>Overcoming client & market resistance to pre-fabrication & standardisation in housing</i></p> <p>Abstract: This proposal builds on an earlier submission to MCNS (Meeting Client Needs through Standardisation) which proposed an examination of the cultural and other barriers to prefabrication in the house-building industry. Its central premise is that, in order to optimise the efficiency and worth of new housing activity, client resistance to the introduction of greater levels of pre-fabrication and standardisation needs to be understood and overcome. The project adopts a broad definition of the 'client', though the primary focus is on the purchaser and end user of housing,. The aims of the research will be achieved in a two stage process, funding for the first stage of which is now sought. The first stage involves the development and testing of new, predominantly financial models through which the resistance to pre-fabrication in housing can be eased. The second stage involves the practical, on-site demonstration of both product and process developments which can increase market penetration of, and confidence in, pre-fabrication and standardisation. The first stage is the primary component which requires research funding. The second stage is a near-market, developmental phase which, it is hoped, will be carried out with industrial sponsorship.</p> <p>Outputs and Deliverables: Unknown</p>	<p><i>Investigator Details:</i> Dr HM Edge The Robert Gordon University Construction, Property & Surveying 01224 263539 Fax: m.edge@rgu.ac.uk</p> <p><i>Investigator Details:</i> Mr RW Pollock The Robert Gordon University Construction, Property & Surveying 01224 263700 Fax: 01224 263777</p> <p><i>Investigator Details:</i> Dr A Al-Hajj The Robert Gordon University Construction, Property & Surveying</p> <p><i>Investigator Details:</i> Mr GA Slaven The Robert Gordon University Faculty of Design 01224 263539 Fax: 01224 263737 g.a.slaven@rgu.ac.uk</p>
<p>GR/M86408/01 <i>Standardised framework for risk assessment & management of private finance initiative projects</i></p> <p>Abstract: The proposal seeks to establish a standard framework for assessment and management of risk associated with the Private Finance Initiative projects within the context of Best Value. Two fundamental requirements of PFI schemes are that the public sector must secure value for money (vfm) and the private sector must genuinely assume responsibility for risk. In essence, optimum risk allocation (through a combination of risk sharing and risk transfer) is required to achieve (vfm). The operation of PFI attributes, therefore, place additional responsibilities for risk management to both the construction sector and the public sector clients' groups, which go beyond the risks relevant to project design and construction. The intention is the thorough empirical research involving a combination of case study materials and interview analyses; involving clients group, PFI operators, construction contractors, and financial institutions best practices will be identified leading to the development of a standardised PFI risk assessment and management framework. Review of literature and analysis of PFI practices within a client's group (local authorities) documented in the research undertaken by the authors for the RICS shows that both clients' groups and private sector are yearning for such framework which should provide a catalyst for effective privately financed projects.</p> <p>Outputs and Deliverables: Unknown</p>	<p><i>Investigator Details:</i> Dr AS Akintoye Glasgow Caledonian University Building & Surveying Telephone: Fax:</p> <p><i>Investigator Details:</i> Professor C Hardcastle Glasgow Caledonian University Building & Surveying 0141 3313630 Fax: 0141 3313696 char@gcal.ac.uk</p> <p><i>Investigator Details:</i> Professor M Beck Glasgow Caledonian University Risk & Financial Services</p>

<p>GR/M97220/01 <i>Standardisation of Window & Cladding Interfaces (Cladd:ISS) (RAIS 1)</i> Abstract: Building on GR/L39179/01 Developing the technical aspects of the Cladd:ISS CD and field testing the working draft Outputs & Deliverables: Web: http://www-staff.lboro.ac.uk/~cvagg/ Cladd:ISS CD available from CWCT, Bath Implementation workshops 2001</p>	<p><i>Investigator Details:</i> Alistair Gibb Loughborough University Civil & Building Engineering 01509 223097 Fax: 01509 223981 a.g.gibb@lboro.ac.uk http://www-staff.lboro.ac.uk/~cvagg/</p>
<p>GR/N01262/01 <i>Network on information standardisation & exchanges in construction</i> Abstract: No abstract available Outputs and Deliverables: Unknown</p>	<p><i>Investigator Details:</i> Professor G Aouad : Salford University Construction & Property Man (Res Cen) 0161 295 5176 Fax: 0161 295 5011 g.aouad@salford.ac.uk <i>Investigator Details:</i> Professor R Cooper Salford University Art & Design (Res Cen) 0161-2956146 Fax: 0161-2956174 r.cooper@salford.ac.uk <i>Investigator Details:</i> Professor M Alshawi Salford University Construction & Property Man (Res Cen) 0161 2955128 Fax: 0161 2955130 m.a.alshawi@salford.ac.uk <i>Investigator Details:</i> Dr M Sun Salford University Surveying 0161 2955293 Fax: 0161 2955011 m.sun@salford.ac.uk</p>

GR/N12787/01

CIMclad: computer-integrated manufacture of cladding systems

Abstract:

The long-term goal of the CIMclad initiative is to deliver similar strategic benefits to the cladding sector, with the adoption of common digital information standards allowing the progressive realisation of computer integrated design and manufacture. It will investigate the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standardisation framework for computer-integrated design and manufacture of cladding systems. The design, manufacture and installation of 'layered cladding walls' (Rainscreen Cladding), which represent a major growth area, especially in the sustainable refurbishment sector, will form the main focus of the work - thus providing a pilot for the cladding sector as a whole. The technical focus of the initial research programme will be on the development of a prototype CIS-like standard, and its practical implementation within one of the new generation of generic object-oriented CAD systems. The proposed research programme will deliver proof-of-concept software, and demonstrate how an ongoing CIMclad initiative can bridge the current absence of specialist engineering software and appropriate open information standards, thus enabling the cladding industry to access substantial ongoing technical and business efficiency improvements.

The project will investigate the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standardisation framework for computer-integrated design and manufacture of cladding systems. The initial focus will be on 'layered cladding walls' (Rainscreen Cladding) which will serve as a pilot for the whole cladding sector. The specific objectives of the project are: 1. To establish the potential for process improvements through the standardisation of procedures and more effective use of information technologies, leading towards computer-integrated design and manufacture of cladding systems. 2. To consolidate and state more formally a set of standard performance specifications for layered cladding walls. 3. To develop a product model to support the major aspects within the specification, design, manufacture and construction of layered cladding walls. 4. To implement and test these concepts via fast-track implementations and industrial deployment of standard object oriented CAD technology, configured to support the product model and incorporate proprietary knowledge from the industrial collaborators. 5. To propose a road map for the cladding sector as a whole to realise computer-integrated design and manufacturing, this in the context of wider developments within the construction sector.

Outputs and Deliverables:

Project still underway Website – <http://www.cae.civil.leeds.ac.uk/current/cimclad>

Several project reports available via the website or by post:

CIMclad – Potential for process improvement, Report 1, Loughborough Uni, 59 pp., 2001, ISBN 1 897911 18 1

CIMclad – ICT usage: current and future, Report 2, University of Leeds, 45 pp., ISBN 0 904280 01 0.

CIMclad – Review of specifications for rainscreen cladding, Report 3, Loughborough University, 18 pp., 2001, ISBN 1 897911 19 X.

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Investigator Details:

Alastair Watson
Leeds University

<p>GR/N34000/01 <i>IMMPREST: interactive model for measuring pre-assembly & standardisation benefit across the supply chain</i> Abstract: The primary aim is to produce an interactive modelling system (IMMPREST) that facilitates the evaluation of benefits arising from the use of pre-assembly and standardisation. The system will support design and procurement decisions for clients, designers, cost advisors, and the delivery supply chain. Additional support for the delivery supply chain will benefit marketing and measurement of business performance. This builds on the pilot study project COMPREST - GR/M39190/01 Outputs and Deliverables: Website - http://www.lboro.ac.uk/research/immprest/index.htm</p>	<p><i>Investigator Details:</i> Dr CL Pasquire Loughborough University Civil & Building Engineering 01509 222895 Fax: 01509 223981 C.L.PASQUIRE@LBORO.AC.UK <i>Investigator Details:</i> Alistair Gibb Loughborough University Civil & Building Engineering 01509 223097 Fax: 01509 223981 a.g.gibb@lboro.ac.uk</p>
<p>GR/R16389/01 <i>Standardisation of Window & Cladding Interfaces (Cladd:ISS) (RAIS 2)</i> Abstract: Building on GR/L39179/01 Disseminating the Cladd:ISS CD through project shadowing and workshops Outputs & Deliverables: Cladd:ISS CD available from CWCT, Bath Website - http://www-staff.lboro.ac.uk/~cvagg/</p>	<p><i>Investigator Details:</i> Alistair Gibb Loughborough University Civil & Building Engineering 01509 223097 Fax: 01509 223981 a.g.gibb@lboro.ac.uk http://www-staff.lboro.ac.uk/~cvagg/</p>
<p>GR/R18734/01 <i>INCONIN: International Collaboration In Construction Innovation</i> Abstract: A network project within CIB Outputs and Deliverables: Project recently commenced – No public outputs to date</p>	<p><i>Investigator Details:</i> Dr GM Winch University College London Bartlett Sch of Architecture & Planning 020 76 79 59 21 Fax: 020 79 16 18 87 g.winch@ucl.ac.uk</p>
<p>GR/R19984/01 <i>Network for the integration of design and construction to foster innovation in the construction industry supply chain</i> Abstract: An enterprise activity with the ultimate aim of identifying research needs in integrated design and production, working very closely with M41. Outputs and Deliverables: Project recently commenced – No public outputs to date</p>	<p><i>Investigator Details:</i> Professor JA Powell Salford University Research & Graduate College 0161 7455464 Fax: 0161 7455553 j.a.powell@salford.ac.uk <i>Investigator Details:</i> Professor D Lenard Salford University 01612955076 (m07769672937) Fax: 0161 295 5011 d.lenard@salford.ac.uk</p>

GR/R20038/01

HASPREST Health and safety implications of pre-assembly & standardisation

Abstract:

The primary aim is to provide guidance on health and safety issues for those using standardisation and pre-assembly in construction.

Outputs and Deliverables:

Project due to start August 2001

Investigator Details:

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Standardisation and customisation in construction

Appendix 4

DETR Funded Projects on Standardisation and Customisation

DETR-funded projects on Standardisation Background, Objectives and Relevant Publications & Outputs

Projects on standardisation currently submitted for DETR funding

HHC9902 *Development of a New Energy-efficient System Using Aircrete for the Whole House.*
H+H Celcon Ltd

Projects on standardisation currently funded by DETR

Projects listed in reference number order

36/8/34 ***Research in support of standardisation on fire resistance***

Contact: Mr W A Morris **Contact tel no:** 01923 661000

Background: The need to harmonise test methods for the determination of the fire resistance of building elements under the Construction Products Directive has highlighted variations in test practice between EC member states. In addition to this, fire resistance tends to be locally designed and built and is very expensive and therefore is not easily replaced. If barriers to trade are to be removed it is essential that test results obtained in one member state are acceptable in another member state. This project is concerned with the harmonisation of control and measurement systems. The work is receiving support from the European Commission and is being carried out in collaboration with other European laboratories.

Objectives: A calibration method for large scale fire test furnaces is being developed together with improved durable calibration elements. The plate thermometer has been accepted as a superior control sensor to the currently used thermocouple. A method of measuring heat flow at the unexposed face is also being developed. Methods for measuring the properties of materials at high temperature are being developed under RILEM TC/129. BRE also maintain calibration standards for radiation measurement in fire tests and are writing a standard procedure for such calibrations for EGOLF.

Relevant publications/other outputs: Not known

36/8/133 ***Development of standards for interoperability***

Contact: Robert Amor **Contact tel no:** 01923 661000

Background: The results from this project will contribute to the eventual commercial implementation and industrial take-up of the Integrated Project Database concept by collecting the results of existing work and creating a common framework based upon their best features. The development and uptake of IPDBs is seen as a major component of the DETR's Construct IT strategy. It impacts on almost every aspect of It in relation to this industry. The development of appropriate standards is still one of the major hurdles to the uptake of IPDBs. The full benefit of IPDBs based on standardised models must be demonstrated to the industry. Tackling product libraries as part of this development will show a major IPDB functionality easily understood by all in the industry.

Objectives: The objectives of this project are: - To demonstrate and promote the benefits of an increased use of data, including object libraries, between construction projects through the use of integrated project database concepts; - To develop appropriate and consensual standards for the representation of libraries, especially product libraries, to enhance interoperability, and to promote these standards through the IAI and within the UK and for the ongoing CIG project; - To test and validate developing standards in the context of an integrated project database. To then use this IPDB to quantify the possible reduction in data re-entry within a project; - To identify components of, and implement, an integrated project database system drawing upon the results of relevant UK R&D work; - To keep a watching brief on international developments and adopting of standards including STEP and IAI.

Relevant publications/other outputs: Not known

36/8/200 **Overcoming barriers to standardised wiring systems**

Contact: Mr A K R Bromley **Contact tel no:** 01923 661000

Background: The results from this project will overcome the barriers to the wider use of standardised, pre-fabricated and innovative wiring systems for power distribution, lighting, IT, fire, security, environmental control and other building management and control services. The benefits will be a reduction in the complexity and improvement the flexibility of power and communications wiring in buildings so that wiring becomes easier and less costly to design, install maintain and upgrade, and also safer and more reliable.

Objectives: The general objectives of the project are: - To overcome barriers to the use of standardised wiring systems at all stages of design, installation, maintenance and upgrading; - To improve the quality and performance, and reduce the whole life costs, of wiring systems. Specific objectives are: - To identify innovative wiring systems and how these are being used; - To determine the benefits that these systems can bring; - To identify the barriers inhibiting the uptake of these technologies; - To determine the measures that will overcome these barriers; - To implement the measures by promoting the benefits among specifiers, designers, installers and users of electrical and electronic building services.

Relevant publications/other outputs: Not known

38/6/92 **Innovation & strategy: the link for building services**

Contact: Anne King **Contact tel no:** 01344 426511

Background: A project undertaken in 1992/3 (PIF No 77640) on the uptake of research showed that there were many instances where BSRIA research has been applied in industry with significant benefit. A second phase of the work has produced a brochure for wide dissemination in industry to persuade senior executives to give more attention to research. This new project will extend the coverage of the study beyond BSRIA's work and BSRIA members and will provide a marketing strategy to follow on from the launch of the brochure and incorporate the results of the new research. More companies will thus be encouraged to apply the results of research, so substantially increasing the return on the original research investment. The benefit will accrue, almost by definition, chiefly to companies who are not traditional funders of research.

Objectives: - To promote the uptake of research by determining and publicising the conditions and organisational mechanisms used in industry to successfully apply the results of research, and the barriers to uptake; - To identify and publicise actual benefits achieved from the application of research by industry; - To develop a hand book giving recommendations of how to exploit research results, particularly aimed at SMEs; - To provide training, and consultancy material for companies to enable them to develop and implement their own research and innovation strategies.

Relevant publications/other outputs: Publications: Promoting Innovation - conditions mechanisms and methodologies (BSRIA TN 5/99). Summaries of Outcomes and Achievements: The project produced: (1) a report on innovation and barriers to innovation; (2) from this, a training pack on the development of innovative strategies in building services which can be used for further training and corporate development. It is already known that one company set up a partnership arrangement following the use of the workshop pack in house.

38/6/124 **A Research Technology Network**

Contact: Mike Smith **Contact tel no:** 01344 426511

Background: This is a proposal to set up a Technology Network of users of research results. It creates an individual, as opposed to corporate network, to increase the use of research results and provide feedback on the usefulness of research and the need for further work. Compared with the cost of research, the cost of dissemination is quite low. This Network will enable the much wider dissemination of results in order that much better value for money may be gained from investment in research whether by Government or industry. The key elements of the Network will be the creation and wide dissemination (of approximately 20,000) copies of an index of research results for the building services industry, feedback through questionnaires and workshops of the usefulness of results as perceived by the Network, and a report on how the Network might be extended to the whole of the construction industry.

Objectives: The objective of the project is to develop and run, for eventual self financing, by March 1998 a Network of users of research. The Network will be aimed at individual users of research. It will provide them with an index of research results and will develop a feedback mechanism for establishing the usefulness of existing research and the requirements for future projects.

Relevant publications/other outputs: Publications: Report available from BSRIA publications. Summary of Outcomes and Achievements: A new, live knowledge network and database of technical and research information for the building services industry, available on the World Wide Web (WWW) and including references to 100,000 items of building services information. Full text copies of all of BSRIA's recent publications are included, bringing recent DETR research to all who access the database. The database is currently available to all BSRIA member companies, and a number of other companies who joined the initial pilot scheme. We have found that it is a very attractive tool for consulting practice librarians, but uptake from engineers themselves is slower. Three additional modules (research alerts, member database, defects database) were developed during the research and available during the pilot study. However following the low use of them at that stage, they have been withdrawn for the time being. Also developed but not yet fully tested is the "What's New" module which allows searchers to easily determine new items that have been added to the database.

38/6/161 *Uptake of productivity improvements*

Contact: Glenn Hawkins **Contact tel no:** 01344 426511

Background and Objectives: This project comprises detailed studies of various innovative productivity improvements following the BSRIA report 'Improving M&E site productivity' (1997). It provides specific, measured results from four live construction projects.

Relevant publications/other outputs: Several reports including: Rowe-Roberts, A. & Hawkins, G. 2000, Uptake of productivity improvements – Feedback from first-run studies on the Stansted Airport terminal extension project, 19 Pages, BSRIA, Old Bracknell Lane West, Bracknell, Berks RG12 7AH.

38/6/169 **Standard Details for Building Services**

Contact: Mike Smith **Contact tel no:** 01344 426511

Background: For building services installation, "the devil is in the detail". Previous BSRIA/DETR research (Improving M&E Site Productivity) demonstrated that the highest levels of installation productivity are achieved on straight runs of pipes, ductwork or cabling, where the routes are clearly indicated and sufficient working space has been allowed, whereas overall productivity is greatly reduced because of time wasted on aspects such as final connections to plant items, congested service areas and features which require collaboration with other building trades. One reason is that for building services design, these parts of the system are seldom if ever detailed on a drawing. Final routes, layouts and configurations for systems are nearly always decided by the tradesmen on site. As a result, we see bespoke solutions for every situation, not all of which work very well, look very nice or are as cost effective as they could be.

Objectives: - To promote the adoption of standard M&E installation details by: - determining which parts of systems could be standardised, and what the time saving or value enhancing benefits would be. (October 1999) - developing the content of standard M&E drawing details through collaboration with engineers from M&E design and contracting companies. (August 1999) - preparing a catalogue of the standard drawings and issuing them as hard copy and software versions for immediate use by engineers. (August 2000)

Relevant publications/other outputs: CD containing all of the standard detail drawings: BSRIA Library of Building Services Details: Ref: CD 10/2000 CIBSE
Journal article: Building services Standard Details

<p>38/6/171 <i>Innovative M&E Installation</i> Contact: Mike Smith Contact tel no: 01344 426511 Background: BSRIA's recent 'Improving M&E Site Productivity' report suggested that a major contributory factor for the poor performance of the UK's M&E trades was the reluctance to embrace innovative installation procedures. In contrast, the project found that other countries are maximising production through the use of improved installation procedures by adopting innovative techniques. The adoption of such new techniques are essential if the UK M&E industry is to maintain it's international competitiveness. Public funding is required to identify, highlight and promote the adoption of improved M&E installation techniques by all sections of the industry to overcome conservative attitudes. Manufacturers claims are often treated with a great deal of scepticism by consultants and contractors and the benefits of change are not always apparent. As an independent research association, BSRIA can help the whole M&E industry to work together to provide a better service for it's clients. Objectives: This study will improve the productivity of M & E contractors by: - Identifying M&E installation techniques used outside of the UK (or not in common use in the UK) that have the potential to improve site productivity. - Highlighting where these new techniques can be used to maximise site production. - Assessing the barriers that may restrict the use of those innovative systems and techniques in the UK. - Producing technical & cost/benefit analysis. - Disseminating the findings of the work. Relevant publications/other outputs: Not known</p>
<p>38/6/181 <i>Update of BMS standard specification</i> Contact: Mike Smith Contact tel no: 01344 426511 Background: BSRIA's standard specification for Building Management Systems (BMS) provides functional specification clauses for BMS equipment and installations. The standard specification is widely used (it is currently in its fourth reprint) and is incorporated in the National Engineering Specification (NES). First published ten years ago the standard specification is now in need of updating, for a combination of technical, application and process related reasons. Central station and other operator interface software has advanced. This includes the potential use of software which allows the operator to obtain system documentation concerning installed control strategies and system configuration details. The lack of adequate system documentation is a widespread problem and seriously hinders operators when trouble shooting and improving/updating BMS. It is important that adequate document generation features are included in a BMS specification. BMS structures have become less hierarchical with an associated growth in smaller, more distributed controllers. It is important that specifications reflect the specification requirements for smaller control equipment which rely more heavily on shared data. Objectives: - To produce and publish an updated standard specification for BMS. (Feb 2001); - To disseminate the published standard specification. (April 2001); - To encourage the widespread exploitation and uptake of the standard specification by industry. (April 2001). Relevant publications/other outputs: Not known</p>
<p>38/7/154 <i>Optimised use of standardisation, pre-assembly & modularisation in construction</i> Contact: Now Ann Alderson Contact tel no: 020 7222 8891 Background: There have been many recent developments in construction design, materials and methods manufacturing techniques, information exchange and procurement methods. Opportunities to use these new technologies are now available to make standardisation, pre-assembly and modularisation viable construction options and effective parts of the construction process. Projects which satisfy individual client needs will be faster and easier to build, of the highest technical and aesthetic standard, and provide value for good money. At this stage, the benefits to be gained from the use of standardisation, pre-assembly and modularisation are most likely to be achieved rapidly through client/procurement initiatives. Objectives: The objective is to provide clients and procurement organisations with detailed guidance and checklists, which they and their principal advisors can use to implement of standardisation, pre-assembly and modularisation, and obtain maximum advantage from them. The guidance will cover the preparation and analysis that are required from inception, through conceptual design, to formulating the project brief, and taking decisions about procurement strategy, and how to achieve the early involvement of contractors, manufacturers and suppliers, and the standardisation of electronic data exchange. Relevant publications/other outputs: Report available from CIRIA publications. Various journal papers</p>

38/7/197 **Standard risk register for the construction supply chain**

Contact: David Churcher **Contact tel no:** 020 7222 8891

Background: Risk management is not used to optimum effect throughout the industry supply chain. Most parties approach risk and try to 'offload' it elsewhere in the chain. Risks are not thoroughly examined, nor collective measures for their management agreed by supply chain members. Even when informal measures are adopted, they are not generally communicated throughout the chain; members may be unaware of a vital risk-related decision taken by another party on the project. The results can be extreme, as in the NATM collapse at Heathrow Airport. Three principal areas need improvement: - risk concepts and terminology are not consistent between project participants, and risks are not clearly identified through the whole supply chain, therefore 'hidden' risks remain; - ownership of risk-mitigation measures are not clearly established, creating confusion over responsibility for managing the risk(s) - lack of documented communication on risk issues results in supply chain members being unable to appraise one another of their expertise or particular ability to bear certain types of risks. This project will promote risk management throughout the industry supply chain, thereby enabling projects to deliver greater value and certainty to clients. It will achieve this by producing a dictionary of generic construction risks, and describe their potential for interaction, together with a glossary of risk concepts and mitigation measures. It will supplement the dictionary by a 'risk register' - a document (similar to a CDM health and safety file) that systematically captures the identified risks to a project, the agreed mitigation measures, and the parties responsible for managing them. The register also contains a travel-log and is passed through the supply chain to clearly communicate the risk strategy.

Objectives: - To publish a dictionary of generic construction risks, and a 'Risk Register' (similar to a CDM 'Health and Safety File'). The dictionary will define individual risks, and the potential for interaction between them. The register will record the risks to a project, the agreed mitigation measures, and the parties responsible for managing them by July 2000 for distribution of the outputs to project funders and CIRIA members.

Relevant publications/other outputs: Report available from CIRIA publications

38/7/204 **Clients' toolbox for demonstrating optimised use of standardisation & pre-assembly**

Contact: Now Ann Alderson **Contact tel no:** 020 7222 8891

Background: The earlier, first phase, of the collaborative research was CIRIA Research Project 532 which identified how standardisation, pre-assembly and modularisation can be used to optimise production conditions, minimise on-site work and use standard products and systems to achieve unique projects more efficiently. In addition to data gleaned from interviews, workshops of experts and site visits, lessons have been identified from other cultures such as the automotive, electronics, power and aerospace industries and from other countries such as Japan, USA and the Netherlands. It has resulted in a high-impact leaflet, entitled Snapshot, a CIRIA Funders Report (FR/CP/55) and the open publication Report 176 is soon to be published. CIRIA proposes to adopt partnering for this next phase in order to maximise the effort and minimise the cost and time of the research. CIRIA's Research Contractor for each of the two previous phases of the work is a consortium of Laing Technology Group and Loughborough University. The consortium won both contracts in open competition and they have developed a close working relation with CIRIA and with the Steering Groups for these projects (See Supporting Information, below). They are not only 'up to speed' – which an alternative contractor would not be – but as there would be a high probability of their being appointed if we were to follow a competitive procurement system there would be a high risk of wasteful effort by many organisations. As with the previous project CIRIA will collaborate with the CRT to ensure an effective industrial input and appropriate focus is maintained. It is anticipated that CRT will make a significant financial contribution both in cash and in kind. The Steering Group needs to have a balanced representation of the relevant professions and industrial interests. This has been achieved to good effect on the previous projects (P1319/RP532 and P1363/RP579). The Steering Group will therefore include a broad range of client organisation representatives (including CRT, CCF, etc.), architects, surveyors, engineers, contractors and specialist suppliers.

Objectives: Much wider appreciation of the advantages that can be gained from the appropriate application of SP&M to construction projects. Demonstrate that the Toolbox, developed in the earlier project (P1363/RP579), can be used effectively to improve construction projects in terms of productivity, predictability, quality and speed to provide better value for money. Use the feedback from the experience of detailed practical application of the Toolbox to refine the procedures and techniques. Prepare the Toolbox in the form of a user-friendly electronic system (CD-ROM or equivalent) for ready application in design offices by all members of the professional team.

Relevant publications/other outputs: Toolbox available from CIRIA. Journal papers eg ECAM 2001. Also Croner Management Guide insert & periodical

<p>38/8/116 <i>Innovative components from UK timber resources</i> Contact: Martin Milner contact_detail.asp?ContactID=225 Contact tel no: 01494 563091 Background: There is a need to encourage exploitation of UK sawn timber and panel product resources, research is needed to identify market need and product types for prototype development. Objectives: The main objective is to undertake techno-economic assessments of engineered timber composite beams using UK timber resources and panel products and to publicise the findings. The project will seek to identify and optimise potential benefits and innovative potential in order to establish a basis for design and development. Relevant publications/other outputs: Report available from TRADA publications</p>
<p>38/8/117 <i>Factory pre-fabrication & construction: demonstration project</i> Contact: Geoff Pitts Contact tel no: 01494 563091 Background: The anecdotal benefits posited of factory prefabrication are widespread; from improved quality, better tolerances, and zero defects, to construction time certainty and improved site safety. Latham cites Stanhope's interest in extensive use of prefabrication. It is also suggested that acceptance of prefabrication opens the door to other process improvements, such as sequencing, Health and Safety benefits, removing interdependencies and facilitating a JIT regime. However, there is little hard empirical evidence that this is the case and many construction projects still contain large work elements that are site based. Research is needed into the real benefits of off-site prefabrication, that can identify tangible benefits to the client and construction design team. Objectives: - To provide tangible evidence in the form of a demonstration project, as to the benefits associated with using factory prefabrication, using time, cost, quality and client satisfaction, as performance indicators. This will be in the form of case study material demonstrating foundation, wall, floor, roof, services and external cladding prefabrication. Relevant publications/other outputs: Trade Press Articles: House Builder July 1999 Trade Press Articles: Local Authority Building & maintenance Trade Press Articles: Building Trade an Industry August 1999 10 Short Studies: Published by TRADA Autumn 2000 4 Case Studies: Published by TRADA Autumn 2000 Seminars: 11&13 January 2000</p>
<p>38/8/121 <i>A sustainable development centre (Zethus Centre) for the housing market</i> Contact: The Palmer Partnership Objectives: To create a centre of sustainable development for the dissemination of construction best practice in the affordable and speculative housing markets. To enhance existing best practice material using information generated and monitored from a number of live construction projects implementing tried, tested and developing technologies, processes and management techniques. Relevant publications/other outputs: Club of innovators (Amphion Consortium); a best practice portfolio for housing construction (collation of existing information plus case study material on five live projects) – print/web and CD: construction and operation of a Sustainable Development Centre: workshops and seminars</p>
<p>38/10/39 <i>Benefits of standardisation in steel design & fabrication</i> Contact: Mr D G Brown contact_detail.asp?ContactID=255 Contact tel no: 01344 23345 Background: Standardisation in steel construction would offer major benefits in terms of ease of detailing and reduced fabrication cost. Each area will be reviewed with the benefits of standardisation identified and quantified in terms of specification, design, production and cost. Standardisation would include rationalisation of section sizes, member connection details, member layouts, composite deck details, brackets and attachments, including to cladding and concrete elements. It is proposed to prepare examples of details and projects where these principles have been successfully employed. This work is needed in order that designers can be kept informed of where significant economies can be obtained by standardisation in construction details and fabrication practice. Objectives: - To investigate and quantify the benefits of standardisation of steel and composite frames in the steel construction industry. The output from this work will be a report, leading to an SCI publication which will contain examples of where standardisation of connection, details, member configurations etc., would lead to quantifiable benefits in cost and speed of construction. Relevant publications/other outputs: Report available from SCI publications</p>

<p>38/10/57 <i>Design guide & innovation of modular units</i></p> <p>Contact: Mr D G Brown contact_detail.asp?ContactID=255 Contact tel no: 01344 23345</p> <p>Background: Cold formed steel (CFS) load bearing panels can be assembled together to form larger, often self-contained load bearing elements. These prefabricated units take the generic name 'modules', because they are relocatable, are often standardised in size and construction and identical units of accommodation can be replicated within a single development. There are now a number of 'high profile' examples of this form of construction. However, there is currently little independent design guidance available for architects and this document would provide some of the essential information to enable them to undertake the design of these elements and to understand the advantages and principles associated with their usage.</p> <p>Objectives: - To prepare a design guide on the use of cold formed steel in prefabricated modular units for housing, other low rise buildings, and as units within high rise buildings. The guide will review the production methodology aspects, and opportunities for new connection techniques. The guide will be presented in a form suitable for use by architects and those responsible for procuring these buildings.</p> <p>Relevant publications/other outputs: Report available from SCI publications</p>
<p>38/19/2 <i>Good practice for small builders</i></p> <p>Contact: Bill O'Neill Contact tel no: 01923 661000</p> <p>Background: The UK construction industry is comprised of mainly small companies, most of who do not read the technical press or belong to a trade group to which information can be directed. It has therefore been difficult to transmit to this group the wealth of technical information generated by BRE in a format suitable for use by these small companies.</p> <p>Objectives: To provide over 30 monthly feature articles providing technical advice relating to good practice in construction and defects avoidance suitable to the small builder. These articles to be published in the magazine Professional Builder (a free journal made available through trade counters of builders merchants with a circulation of over 100,000.</p> <p>Relevant publications/other outputs: Report available from BRE</p>
<p>38/19/158 <i>Innovation & best practice in flexible & modular building solutions</i></p> <p>Contact: Alan Gilham Contact tel no: 01923 661000</p> <p>Background: There is an increasing demand for sustainable building solutions which subsequently increase the need for more adaptable buildings; reduced consumption of resources; and improved quality and performance from the industry. The social housing sector is one such area where flexibility of provision is necessary to meet the changing demands brought about by: an ageing population; the changing family size, mobility; moves into and out of home ownership; etc. Housing providers are faced with the problem of ensuring that investment decisions make the most of resources for local provision today, yet leave the flexibility for future demand? The Southern Housing Group have made the decision to consider modular housing as a solution. This project will build on: - existing commitments to invest in the application of modular buildings from the Southern Housing Group; - established expertise of modular building providers that is manufacturers such as Terrapin, etc - environmental assessment and research capability of BRE. The approach will be to provide a background study on the potential for the application of modular buildings addressing issues such as: durability, availability, quality, perceptions, cost, etc and present this in terms of market viability. The project will go on to monitor the decision making process on the project through design, procurement and construction stages, identifying the issues which affect the use or exclusion of modular buildings.</p> <p>Objectives: This project will use Project 2001 as a demonstration project and will run in parallel with 3 key objectives: - To study the technical possibilities for modular buildings, reviewing the market potential, current positioning and likely trends in demand and supply of flexible buildings over the next 25+ years. - To study the development process and application of modular buildings in the context of flexible, adaptable and sustainable solutions to the changing demands of property clients. - To study specifically the extent to which modular housing can assist social housing providers with flexible housing provision to meet unpredictable future demand.</p> <p>Relevant publications/other outputs: Not known</p>

38/19/188 **Standardisation of datasets for building life cycle energy & environmental modelling**

Contact: Dr F Parand **Contact tel no:** 01923 661000 **Email:** parandf@bre.co.uk

Background: Computer modelling of building energy and environmental performance is an important tool in predicting initial and operating costs of a proposed building or renovation scheme as recognised in the Egan report. It is also valuable for predicting energy use requirements and associated CO2 emissions. Essential to the effective use of such modelling is data on thermal properties. Clients, cost consultants, and building services engineers require a standard set of data that enables the comparison of different choices and options and improves predictability. The existence of standard datasets will also improve feedback from operation to design. There is currently no accepted standard dataset for use in UK buildings. Many different software tools are available for such modelling; most have some form of database incorporated to assist the user in selecting appropriate values for thermal design data. Also, various organisations (e.g. CIBSE, ASHRAE, BSRIA) have published manuals or Codes of Practice which provide collections of data. There are many variations between these different sources. As a result, discrepancies may occur if data are applied from more than one source. The results of this work will improve the consistency and reliability of simulation results, through providing a common source of design data for use by practitioners. This will improve the use of building energy and environmental modelling (BEEM) software as a measure for determining and comparing sustainable construction options.

Objectives: The objective of this project is to improve the quality of, and confidence in, results of building energy and environmental modelling, by providing design professionals and software developers with a fully-referenced dataset for thermal design data.

Relevant publications/other outputs: website <http://cig.bre.co.uk/datasets/>

38/19/190 **Timber sector best practice initiative**

Contact: Peter Bonfield **Contact tel no:** 01923 661000

Background: The Timber Best Practice Initiative will identify the current business processes and management methods used within the timber supply chain. It will analyse the success and limitations of these to identify the barriers preventing innovation and will present the opportunities for improving communication of best practice. It will identify exemplars of best practice currently operating and will initiate new exemplars. These will be presented as case studies to clearly demonstrate the benefits to others and help motivate improvement and innovation. A communications and marketing plan will be developed in partnership with the project Advisory Group (comprised of key decision makers from along the supply chain) to encourage and motivate the timber supply chain to take up and exploit best practice. This will help optimise the impact of the project.

Objectives: The principal objective of this project is to provide the timber industry and Government (through the CBPP) with a Best Practice Initiative that encourages and motivates the implementation of best practice management methods and business processes. The project will be delivered by the CTTC/TTL partnership. It additionally has comprehensive and widespread support from along the entire timber supply chain. This composition, together with the close working relationship envisaged with the CBPP PMU, will be exploited to ensure that the project is completed within the planned time frame.

Relevant publications/other outputs: Not known

39/3/176 **House wall construction for the future**

Contact: G J Edgell **Contact tel no:** 01782 746 476

Background: The project has developed from a consultation exercise that has demonstrated that the current and future changes to the Regulations have different consequences and costs for the various parts of the building industry. The effects on builders differ dependent on their current policy, for example, those on suppliers of timber frame housing can be very different to those on suppliers of cavity walling and indeed within the latter group there are different effects depending on the current method of satisfying the Regulations. Similarly the effects on suppliers of insulating materials, structural materials, components, insurance etc all differ.

Objectives: - To determine and encourage the use of a small range of wall forms that retain the designers flexibility of choice of structural form, ensure low risk of rain penetration, ensure overall wall thicknesses are economic, enable improved levels of thermal insulation to be achieved in a practical, buildable, acceptable way and which show genuine benefits on life cycle costs, energy usage and CO2 emissions.

Relevant publications/other outputs: 9 page summary and detailed reports available from CERAM - However, following review of the project report it has become apparent that this project has not really dealt with standardisation issues, mainly concentrating on 'traditional' wall construction.

<p>39/3/239 <i>Transfer of advanced manufacturing technology to construction</i> Contact: Richard Barlow Contact tel no: 01734 875123 Background: The aim is to apply novel 'design to manufacture' knowledge based engineering technology to a 'design to order', industry such as construction. The project outlines a route for transferring proven technology between industries. It is expected that adoption of such methods will offer considerable scope for time reduction in various stages of construction, achieving better value for money, particularly by decision support at concept stage. In addition to the benefits to individual projects, it is anticipated that the UK construction industry could benefit enormously, producing better buildings, and offering a useful boost to the UK industry's drive for improved productivity. Objectives: - To use knowledge based engineering (KBE) to enable visualisation of design alternatives within lift manufacture, carried out with Schindler Lifts using their component catalogue. Other work in progress includes projects which demonstrate how to apply the technology in a similar way to aircraft loading bridges and aprons, baggage sorting systems and building cladding components. Relevant publications/other outputs: Report available from University of Reading</p>
<p>39/3/284 <i>Rationalisation of flat slab reinforcement</i> Contact: Charles Goodchild Contact tel no: 01344 762676 Background: Within the construction industry there are many different views about what constitutes the most economic way of reinforcing concrete. This is especially true of reinforced concrete flat slabs where strict adherence to codes can give 60 reinforcement arrangements. Comparative studies are proposed to evaluate the benefits of rationalising reinforcement sizes and spacings, using bespoke prefabricated mats or fabric, and using different methods of punching shear provision. The work will involve producing rationalised and prefabricated layouts of reinforcement to be used in the in-situ building of the European Concrete Building Project (ECBP) at Cardington, and measuring and disseminating the time/cost benefits. Objectives: The primary objective of this project is to reduce the costs of flat slab construction by disseminating meaningful guidance on the rationalisation of reinforcement. The reduction of complexity, and the benefits of increased rationalisation and prefabrication will improve the quality and competitiveness of flat slabs and will have important spinoff benefits for other areas of the construction industry. Relevant publications/other outputs: BCA Publication 97.376: Rationalisation of Flat Slab Reinforcement Concrete (November 2000): Best Practice Guides Seminars: BRE Cardington, 5 April 2000 Struct E, 3 July 2000: full 200 page report available from Reinforced Concrete Council: 2 page high impact publicity document (Best Practice Guide).</p>
<p>39/3/452 <i>Rationalisation in standardised construction</i> Contact: Nigel Graham Contact tel no: 01582 424200 Background: One contribution to achieving the objective of reducing real construction costs is to significantly improve site performance and productivity. To achieve this performance benchmarks must be set for the whole process and against which the effect of subsequent process change can be measured. At the present time the construction industry, unlike manufacturing, is notoriously short of such benchmarks. Indeed the culture for process performance monitoring is almost universally absent. Objectives: - To reduce construction time by identification and elimination of process bottlenecks, to encourage a wider use of standardised components, to reduce necessity for re-work and to raise construction quality all within a framework of reduced cost. It is intended that the project will deliver relevant performance metrics and to exemplify the benefits of process change which though dissemination and example will diffuse through the whole of the construction industry. Relevant publications/other outputs: Project terminated. Case study on the construction of the Gatwick Travel Inn is available</p>

39/3/459 **Systems approach to timber floor design & manufacture**

Contact: L R J Whale **Email:** solutions@timbersolve.freeserve.co.uk

Background: In spite of being cost-competitive, the fitness-for-purpose of existing timber floors is increasingly being questioned due to shortcomings such as shrinkage, 'bounce', piecemeal on-site construction and routing of services. Some of these are addressed by emerging reconstituted wood products such as I-joists, but these have their own drawbacks in terms of fire resistance, high cost, imported origin, and inappropriate joist depths. This industry-led project will establish new wood-based domestic flooring systems which greatly improve upon current performance levels, whose installation is simple and whose design and manufacture is off-site.

Objectives: The development of a new wood-based domestic flooring system which is economic and greatly improves upon the current technical shortcomings of traditional timber joisted floors such as shrinkage, 'bounce', piecemeal on-site construction and the routing of services. - To achieve this by developing a standardised planar wood-based flooring system whose design and manufacture is off-site, facilitated by computer software, and whose installation is simple. - To ensure rapid exploitation of the engineered floor system so developed by way of computer software for its design, published guidance on its design, manufacture and installation, and nationwide dissemination seminars to specifiers.

Relevant publications/other outputs: Not known

39/3/480 **Standardised process improvement for construction enterprises (SPICE)**

Contact: Marjan Sarshar [contact_detail.asp?ContactID=171](#) **Contact tel no:** 0161 745 5000

Background: This project will consist of a transfer of best practice from the IT industry to the construction sector. It aims to repeat the success of the process and procurement improvements in the IT industry and to communicate this best practice to the construction industry. SPICE will refer to the Software Engineering Institute's Capability Maturity Model based on a Total Quality Methods now widely used in the IT industry to ensure efficient procurement.

Objectives: - To promote process procurement improvements through the use of technology transfer from the IT sector to the construction sector as a complimentary approach to current benchmarking initiatives.

Relevant publications/other outputs: 42 page report available from University of Salford, Construct IT – Introduction to SPICE
Introductory video and 4 page high-impact publicity output – SPICE (also from Salford)

39/3/507 **Good building guides**

Contact: Stuart Mead **Contact tel no:** 020 7505 6600

Background: The standard of construction in the UK is generally lower than that of our major competitors in Europe. Encouraging better practice is one way in which the community can reduce the bill for coping with faults and defects and improve UK competitiveness. Site related faults represent a higher proportion of total faults than a decade ago. Declining craft skills and rapid changes in materials and methods may be major factors. In addition, much guidance is not in the appropriate format for site-based use.

Objectives: - To improve the application of good building practice on site, among small and medium sized building companies. Good Building Guides also aim to support the Department in meeting policy and statutory obligations at a practical level; - To publish regularly new Good Building Guides and to review existing Guides, all of which will gradually build into a loose-leaf textbook of good practice.

Relevant publications/other outputs: Not known

39/3/538 ***Key industry publications promoting standardisation of constructional steelwork***

Contact: Chris Bowser **Contact tel no:** 020 7839 8566

Background: The project's central aim is to update four key publications in the constructional steelwork sector, namely: The National Structural Steelwork Specification for Buildings (NSSS) The Commentary on the NSSS The Handbook of Structural Steelwork Structural Fasteners and their application. The need for this work is now inescapable, and one common underlying reason for the necessity of this project is the plethora of new national and international codes and standards. Each publication contributes in its own way toward the concepts of standardisation, dissemination of key information, and best practice guidance. There is no clearer demonstration of the benefits of standardisation in the specification of structural steelwork than the NSSS, which since its inception in 1989, has become the standard specification (representing and promoting good practice) for over 60% of all steelwork construction contracts. It represents a balance between what Clients/designers should be specifying and requiring and what Steelwork Contractors can economically and practically achieve – it provides a model of best practice in the fabrication and erection of constructional steelwork. Its success is based on this “equal-handedness”, achieved through the original formation of a balanced steering group comprising representatives of the Institutions, designers, Government and steelwork contractors.

Objectives: To provide updated versions of: - The National Structural Steelwork Specification for Buildings (NSSS) - The Commentary on the NSSS - The Handbook of Structural Steelwork - Structural Fasteners and their application - The development of course/seminar programmes on H&S legislation.

Relevant publications/other outputs: Not known

39/3/586 ***Facilitating the benefits of technological innovation***

Contact: Stephen Gregson **Contact tel no:** 01225-320600

Background: The one area in which such clients are less able to gain the benefits of innovation (not surprisingly, perhaps, since they generally lack the technical understanding) is that of the building itself - how it works, how it is designed, how it is constructed, how it performs during its life. Some notable clients such as BAA and Slough Estates have radically changed the way in which they design and procure construction projects. However, clients such as these are very experienced as construction clients, and consequently are very informed in the whole construction process. Some technical innovations have been embraced by clients, the most notable in structural engineering perhaps being the opportunity for long span office floors using cellform beams. The situation is more difficult for occasional building clients who have to rely on the advice of professionals who, themselves, may not fully understand how best to liberate the benefits to be gained from good, well-managed technical innovation in construction projects.

Objectives: · To identify the barriers to innovation in construction projects and produce a widely read report on these barriers and how they can be overcome. · To report on the previous use of innovation on projects - through case studies published on the internet and through M4I and the Reading Construction Forum. · To provide guidance to clients and project managers on the use of innovation on construction projects. To circulate the reports and the knowledge obtained from the study by means of seminars, journals and via the Reading Construction Forum and M4I.

Relevant publications/other outputs: Not known

39/11/3 *Managing the brief as a process of innovation*

Contact: Peter Barrett **Contact tel no:** 0161 745 5000

Background: This project aims to give people, with a desire to improve their briefing practice, three things to stimulate sustained, better briefing. First, a choice of key improvement areas, known to impact positively on a wide range of problem areas. Second, a large number of selected examples from other peoples' experience. Third, an explicit, realistic, step-by-step change process that those wanting to make the journey can follow. In 1964 the Banwell report stated that insufficient resources were devoted to defining project requirements and that this led onto many problems in the construction process thereafter. Thirty years later, the 1994 Latham Report concluded that, amongst other things, more effort was required to understand clients' needs. Clearly the briefing process is seen as both critical to successful construction and problematic in its effectiveness. Furthermore, this is a particularly intractable problem that does not seem to go away.

Objectives: The objective of the project was to produce a briefing guidance tool that would enable the benefits of innovation during the design & commissioning process to be addressed to the benefit of all parties.

The project has achieved two major advances. First, by studying briefing processes in detail from the points of view of many people and a number of projects it has been possible to identify the most influential problem areas and propose practical ways to address them in order to achieve improvement in briefing practice. Second, through a process of action research the above proposals have been refined and illustrated, but more importantly, an understanding of the blockages to implementation has been gained and strategies to overcome these problems provided and illustrated. The main output of the project is a book Better Construction Briefing to be published by Blackwell Scientific in the Spring of 1999. This is written in a two-column format with material in the main text accompanied by commentary in the adjacent column. This is designed to reflect the lessons learnt about implementation, making the material more readily usable by those in practice. In addition to support this, more detailed material on CD is being made available together with video material. Again these multiple media should assist take-up of the findings.

Relevant publications/other outputs: Publications: (1) Barrett, P S, Hudson, J and Stanley, C (1996), "Is briefing innovation?" In D Langford and A Retik (eds.) The organisation and management of construction: Shaping theory and practice, Volume 3: Managing Information, Chapman and Hall, London, pp87-95. (2) Barrett, P S and Stanley, C, 1996, "Construction briefing: Getting beneath the surface", In proceedings of CIB W-96 Conference: Managing Design Quality, Nottingham University, 1996. (3) Barrett, P S and Rein, S, 1997, "UK improvement example from the 1990's and forecast for the 2000's", in Transfer of construction management best practice between different cultures, edited by Odd Sjøholt, CIB publication 205, Rotterdam, Netherlands, pp176-182. (4) Barrett, P S and Stanley, C, 1999, Better Construction Briefing, Blackwells Scientific, Oxford, due to be published in the Spring. (5) Barrett, P S, Hudson, J and Stanley, C, 1999, "Good Practice in Briefing", International Journal of Automation in Construction. Summary of Outcomes and Achievements.

39/11/6 *Development of decision-making tools for controlled innovation in construction*

Contact: John Rogerson **Contact tel no:** 01234 750111

Background: An established method for improving the efficiency of the design of manufactured components is to include ease of manufacture and assembly as key inputs to the design process. Decision support tools have been developed to aid manufacturing design. Construction design has some similarities but some differences to product design so the justification and aim of the work is to examine the construction design process to see to what extent and how decision support tools, analogous to those used in manufacturing industry, could be applied to improve and control better the construction design process.

Objectives: - To analyse the consequence of design decisions. This will be done by reviewing, on a normalised basis, design change records from a number of projects. This provides generic data on the problem of design changes and their consequence. The analysis of existing briefing and design decision making processes cannot be done on historical data because of the inadequacy of records, so a briefing and design making template is used to record actions in real time. An evaluation of IT tools is being made to establish the constraints for decision making tools so that a credible scenario for a decision making tool can be devised.

Relevant publications/other outputs: Report available from University of Cranfield: Conference paper ARCOM 98 & 2000 – Modelling briefing and design decision making in construction: BRE conference Oct 1998 – A quantitative study of post contract award design changes in construction (CME Journal) – Authors Morris, Jared, Rogerson.

<p>39/11/8 <i>Design information methodology & tools for the management of detailed building design</i> Also EPSRC projects GR/K74197 and GR/M52830 Contact: Mike Murray Contact tel no: 01789-204288 Background: As in construction management 30 years ago, significant improvements in design management are now possible and hence substantial capital, design and construction cost savings. This has come about as a result of greater understanding of the process and it's importance, combined with the availability of appropriate computing power. This research aims to deliver improvements in multi-disciplinary detailed building design by developing models of the detailed design phase and creating a prototype software tool to optimise design task order and to analyse the effects of change. This project will progress research at Loughborough University in the field of design management. Objectives: - To produce, verify and validate a generic model of the activities and design information flows during the detail design of a building within and across various design, construction and client organisations. - To produce prototype design planning software to link all aspects of the modelling and analysis to industry accepted project management software. - To test, validate, review and improve software by application to current construction projects. - To identify key data flows, design inputs and co-ordination issues during design. - To produce a functional specification for the further development of the prototype software. Relevant publications/other outputs: AdePT is being exploited as a commercial exercise. Several journal papers incl Integrating design in the project process, Austin, Baldwin, Baizhan, Waskett, ICE Nov 2000 Planweaver software based on ADePT – more info www.thebiw.com 18 page Report available from AMEC 36 page report available from Loughborough University</p>
<p>39/11/17 <i>Standardised process improvement for construction enterprises</i> Contact: Marjan Sarshar Contact tel no: 0161 745 5000 Background: The proposed project will build up current process management research at Salford University to develop and extend a standard framework for process improvement to enhance the effectiveness of facilities management activities. This research need has been identified and championed by NHS Estates. The process improvement approach advocated carefully integrates hitherto underdeveloped supply chain dimensions, and links facilities management processes to overall business performance effectiveness through the Business Excellence Model and appropriate measurement techniques. The project outcomes will be the product of collaborative research with committed industrial partners employing appropriate and rigorous case study and workshop research methodologies which have been validated and honed on previous research projects. Objectives: To develop a standardised process improvement framework, which is aligned with construction SPICE, for facilities management. To develop an appropriate process maturity assessment tool. To link the process improvement initiative with business improvement measure and targets. To link the model with the Business Excellence Model, and other relevant industrially accepted models Relevant publications/other outputs: Not known</p>

39/12/2 **Standardisation of window & cladding interfaces (Cladd:ISS)**

Contact: Alistair Gibb **Contact tel no:** 01509 223907

Background: Interfaces between elements of buildings or the work of different trades, particularly complex aspects such as cladding, generate problems throughout the construction process. Effective interface management, including appropriate standardisation of processes and details, will increase value for money for clients, reduce costs and shorten project durations. This research will facilitate cultural change in the cladding industry by better management of the design development process particularly regarding construction interfaces. This will be achieved through best practice guides covering both the technical and process aspects of window and cladding interfaces, particularly for 'off the shelf' systems.

Objectives: - To produce a strategy for appropriate standardisation of cladding interface design. This includes a directory of standard interfaces and procedures for appropriate implementation within a dimensional framework. Deliverables are an interface directory, a full 'paper' document with frameworks for technical and process strategies and an interactive CD. - To produce a strategy for interface design process improvement, incorporated within the full 'paper' document and interactive CD. - To demonstrate that effective interface consideration is essential for good design and construction. This is achieved by the implementation of the deliverables, in particular the maintenance review which considers life-cycle issues of cladding interfaces.

Relevant publications/other outputs: Cladd:ISS CD available from CWCT, Bath: several conference papers (CWCT, ICBEST): RAIS project is running a series of implementation workshops with industry.

39/12/5 **Standardisation in brickwork construction**

Contact: Nashwan Dawood **Contact tel no:** 01642 342403

Background: In order to achieve the objectives of the research work, the following activities are being undertaken: - A literature review and study of previous and current development of brickwork systems, in Europe, USA and Asia. - The identification of current practices and the potential for proposed development. The participating partners will contribute in knowledge, case studies and information. In order to develop an industrial consensus, a wide industrial survey will be conducted using the semi-structured interviews approach. - Development of recommendations for standardised approaches to procurement, design and specification for prefabricated solutions. This includes identification of potential approaches to integrating business processes. - The measuring and benchmarking of proposed solutions. This includes cost/benefits of the proposed procedures. The cost and time savings that can be achieved through re-engineering business processes will be assessed.

Objectives: This proposal addresses the scope for improving the efficiency of construction involving standardisation of brickworks by harnessing the synergy between technological development in the area of design, fabrication, assembly and site construction technique, and business process development. The specific objectives are: - To evaluate previous and current research work in the area of standardisation and, in particular, the standardisation of brickwork; - To identify current practices and the potential for developing standardised solutions; - To identify guidelines and best practice for standardisation of brickwork; - To measure and bench mark proposed standardised procedures/products.

Relevant publications/other outputs: Website www.sst.U0011809/external/

Various conference papers: Venice 1999, ARCOM 99, IBMAC Madrid 2000, IstructE 2000.

39/12/6 ***Innovation in standardised component systems in housing***

Contact: James Barlow **Contact tel no:** 01273 877166

Background: This project brings skilled researchers from engineering and technology management, logistics and systems dynamics, planning and regulatory policy, together with leading housing suppliers and clients. The main activities will involve developing, testing and evaluating two sets of demonstration houses. Pathfinder I will test immediate costs, benefits and barriers to component-based approaches, by introducing innovative, standardised component systems in two houses.

Pathfinder II will test larger-scale applications in demonstrators in the public and private sectors. Our work will involve: - Analysis of changing housing markets, user requirements and key technical trends; - Evaluation of supply-chain management issues; - Development of evaluation framework for Pathfinder I and identification of opportunities to test innovative standardised systems, facilitation and evaluation; - Development of a route map for Pathfinder II, facilitation and evaluation; - Provision of user needs feedback to collaborators, together with supply-chain and organisational recommendations; - Development of generic technical specifications and recommendations for planning and building regulation policies.

Objectives: - To develop a component-based approach similar to that used in manufacturing and in housing industries in other countries to transform the delivery of housing in the UK; - To evaluate different technologies for component-based housing production; - To evaluate the costs and benefits of increasing flexibility to improve customer choice; - To evaluate the implications of a component-based approach for supply-chain management; - To evaluate implications of this approach for planning and regulations; - To assess the trade-offs in cost, time flexibility and quality for : traditional site-based work; the use of component systems in new site-assembly processes; and meeting customer requirements.

Relevant publications/other outputs: Project due to finish September 2001 – Public dissemination will follow

Links to DTI visits to Japan – report due in May 2001.

39/12/7 ***Building services standards solutions implemented in CAD***

Contact: Nick Barnard **Contact tel no:** 020 8784 5784

Background: Standardisation is widely recognised as a key element in reducing design time, cutting construction costs and ensuring efficient design solutions. Whilst standardisation of buildings as a whole is not generally feasible because of their unique site and usage requirements (and undesirable from an aesthetic point of view), there is scope for standardisation of the component systems and elements. One area of considerable potential is building services contained within plant rooms, ceiling voids and vertical risers. For given systems (eg fan coil), components are drawn from a (relatively) fixed range of alternatives with definite relationships and interactions between them. Three-dimensional spatial layouts of the services and their integration with one another and other building elements are governed by a set of more or less well understood rules. Implementing these rules and other information relating to design, construction, operation and maintenance in CAD will facilitate both data capture/re-use and enable solutions to be readily customised to suit particular constraints (eg moulded to suit spatial constraints). The primary scientific/technological novel issue being addressed is object behaviour and knowledge encapsulation for standard solutions within the CAD environment. This should result in productivity/quality gains to users/beneficiaries involved in the construction process. The potential economic/social benefits arising from the work include cheaper, higher quality buildings. The research is important as it will help to realise the potential role which CAD can play in the effective utilisation of standard solutions. By considering the interaction between components, it will also address issues within the "Greater Standardisation and Connectivity of Components" area. The project will contribute to the MCNS target objectives of cost reduction, reducing non-value added activities, and increase the use of standardisation. The intended incorporation of pre-fabrication in the solutions will also reduce the use of site labour and increase the process of off-site manufacture and on-site assembly.

Objectives: The aims and objectives of this project are: - To identify a set of rules governing the layout, sizing and detailing (component selection) of building services in plant rooms, vertical risers, and ceiling voids; - To define a set of standard solutions; - To implement the standard solutions in an industry standard CAD system; - To test and evaluate the standard solutions against a conventional one in a benchmarking exercise; - To report the findings and conclusions as widely as possible to potential beneficiaries.

Relevant publications/other outputs: Project just finished – final report imminent – public dissemination to follow

<p>39/12/8 Standardisation & skills: a transnational study of skills, education & training for prefabrication in housing</p> <p>Contact: Nicholas Gould Contact tel no: 020 7911 5811</p> <p>Background: The aim of the research is to assess how far the manufacturing-based methods in the British construction industry is influenced by existing skill and education/training structures and to suggest areas for improvement. It will: identify different forms of prefabrication and standardisation associated with different skill constellations in Britain, Denmark, Germany and The Netherlands; describe the skills (including the degree of multi-skilling), qualifications and training of all the different participants in more traditional housing construction compared with those for non-traditional forms of construction; outline the related business processes(including client/contractor/subcontractor relations) and supply chains (from design to manufacturing to assembly) and firm /project organisation. The focus is on a selection of housing association projects and a survey will be conducted of the housing associations, designers, contractors, subcontractors and operatives concerned. The project is for two years and its output is a research report/book, articles, handbooks and a summary booklet for wide dissemination through a conference, seminars and publications.</p> <p>Objectives: - To assess how far the extension of manufacturing-based methods in the British construction industry is deterred through existing skill and educational/training structures. - To describe the skills, education and training of personnel at all levels involved in more traditional housebuilding construction using standardised, prefabricated components - with examples from Britain, Denmark, Germany and The Netherlands. - To assess the degree of multi-skilling entailed in traditional and innovative construction . - To identify and define the different constellations and qualities of skill in the four counties. - To draw up a skill classification matrix referring to type of process, firm and client, and recommendations on training and education requirements. - To disseminate the findings as widely as possible.</p> <p>Relevant publications/other outputs: Project just finished – Final report imminent – Workshop 4/5/01 – Journal papers expected</p>
<p>39/12/10 Standardised framework for risk assessment & management of PFI projects</p> <p>Contact: A Akintoye Contact tel no: 0141 331 3626</p> <p>Background: The proposal seeks to establish a standard framework for assessment and management of risk associated with the Private Financial Initiative projects within the context of Best Value. Two fundamental requirements of PFI schemes are that the public sector must secure value for money (vfm) and the private sector must genuinely assume responsibility for risk. In essence, optimum risk allocation (through a combination of risk sharing and risk transfer) is required to achieve vfm. The operation of PFI attributes, therefore, place additional responsibilities for risk management to both the construction sector and the public sector clients' groups, which go beyond the risks relevant to project design and construction. The intention is that through empirical research involving a combination of case study materials and interview analyses; involving clients group, PFI operators, construction contractors, and financial institutions best practices will be identified leading to the development of a standardised PFI risk assessment and management framework. Review of literature and analysis of PFI practices within a client's group (local authorities) documented in the research undertaken by the authors for the RICS shows that both clients' groups and private sector are yearning for such framework which should provide a catalyst for effective private financed projects.</p> <p>Objectives: - To investigate the approaches used by private sector (contractors, operators and risk management professionals) in the assessment of PFI risks and to establish how and why these specific methods of risk assessment are chosen. - To analyse, in conjunction with the previous research, sponsored by the RICS, prevalent practices of risk assessment and risk management of public sector client groups. - To investigate the framework used by financial institutions to standardise the risk assessment and management across the financial sector. - To identify best practice in the risk assessment and risk management approaches used by contractors, public sector client groups and financial sector investors. - To investigate the compatibility between these approaches. - To develop, on the basis of the above results a standardised state-of-art assessment and management of risk model for PFI schemes which, applicable across sectors, provides for optimum assessment and management of risk associated with PFI projects. - To identify the relationship between the model, the Best Value requirements for public sector management, and the best practise models identified above.</p> <p>Relevant publications/other outputs: Not known</p>

39/12/12 *Computer integrated manufacture of cladding systems*

Contact: Chimay Anumba **Contact tel no:** 01509 222620

Background: The long-term goal of the CIMclad initiative is to deliver similar strategic benefits to the cladding sector, with the adoption of common digital information standards allowing the progressive realisation of computer integrated design and manufacture. It will investigate the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standardisation framework for computer-integrated design and manufacture of cladding systems. The design, manufacture and installation of 'layered cladding walls' (Rainscreen Cladding), which represent a major growth area, especially in the sustainable refurbishment sector, will form the main focus of the work - thus providing a pilot for the cladding sector as a whole. The technical focus of the initial research programme will be on the development of a prototype CIS-like standard, and its practical implementation within one of the new generation of generic object-oriented CAD systems. The proposed research programme will deliver proof-of-concept software, and demonstrate how an ongoing CIMclad initiative can bridge the current absence of specialist engineering software and appropriate open information standards, thus enabling the cladding industry to access substantial ongoing technical and business efficiency improvements.

Objectives: The project will investigate the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standardisation framework for computer-integrated design and manufacture of cladding systems. The initial focus will be on 'layered cladding walls' (Rainscreen Cladding) which will serve as a pilot for the whole cladding sector. The specific objectives of the project are: 1. To establish the potential for process improvements through the standardisation of procedures and more effective use of information technologies, leading towards computer-integrated design and manufacture of cladding systems. 2. To consolidate and state more formally a set of standard performance specifications for layered cladding walls. 3. To develop a product model to support the major aspects within the specification, design, manufacture and construction of layered cladding walls. 4. To implement and test these concepts via fast-track implementations and industrial deployment of standard object oriented CAD technology, configured to support the product model and incorporate proprietary knowledge from the industrial collaborators. 5. To propose a road map for the cladding sector as a whole to realise computer-integrated design and manufacturing, this in the context of wider developments within the construction sector.

Relevant publications/other outputs:

Project still underway Website – <http://www.cae.civil.leeds.ac.uk/current/cimclad> Several project reports available via the website or by post:

CIMclad – Potential for process improvement, Report 1, Loughborough University, 59 pp., 2001, ISBN 1 897911 18 1

CIMclad – ICT usage: current and future, Report 2, University of Leeds, 45 pp., ISBN 0 904280 01 0.

CIMclad – Review of specifications for rainscreen cladding, Report 3, Loughborough University, 18 pp., 2001, ISBN 1 897911 19 X.

Standardisation and customisation in construction

Appendix 5

Standardisation and Customisation: Professional Journal Review

Title	Journal	Author	Date	Page	Stand Process	Stand Product	Stand Misc	Pre-Ass Misc	MB	VPA	NVPA	Residential	Emergency/Te	M&E	Measurement	Health & Safety	Systems and Organisations	Country (if non-UK)
An industrial revolution	Building	Bingham T	14-Aug-98	35	X													
Benefits of standardisation	Construction Monitor	Anon	Nov-00			X		X									CIRIA, Loughborough, Laing	
Charles turns techno	Building design	Fairs M	18-Jun-99	6		X												
Clients set standards	Building Design	Long K	03-Mar-00	8	X												Construction Round Table, CIRIA, DETR, BAA, Laing, Loughborough University	
Cold formed steel construction standards	New Steel Construction	French V	Oct/Nov 98	22-25		X												
Demonstrating economy	Architect's journal	Slavid R	26-Aug-99	40-41		X												
Divided by technology	New Civil Engineer	Mylius A	07-Dec-00	24-26	X													
Document changes ease innovation	Building design	Long K	20-Apr-00	9		X		X										
Don't buy Beta	Building	Delargy M	05-May-00	38-39	X													
DTI demands more standardised design	Building design	Mason S	15-Sep-00	6	X													
European concrete building project results to benefit industry	Reinforced concrete					X												
Facing up to interfaces	Architects journal	Fox S & Cockerham G	13-Jan-00	32-33		X												
M41 calls all architects	Building design	Long K & Hattersley L	28-Jan-00	7		X												
Mace to launch off-the-shelf offices	Building	White D	19-Nov-99	18		X												
Matching design and production	Architects journal	Fox S & Cockerham G	09-Mar-00	50-51		X											Barlow Group & Sheffield Hallam	
More Peter Rogers than Richard Rogers	Building	Pearson A	24-Nov-00	40-45		X												
New EDI standardisation underway	Modern Steel Construction		Jul-98		X													
New electronic data interchange standardisation underway					X													
New system to help push data standardisation	Construction news	Anon	20-Apr-00	2	X													
Office politic	Building	Macneil J	21-Jul-95	40-41	X													

Title	Journal	Author	Date	Page	Stand Process	Stand Product	Stand Misc	Pre-Ass Misc	MB	VPA	NVPA	Residential	Emergency/Te	M&E	Measurement	Health & Safety	Systems and Organisations	Country (if non-UK)
PIMS number one	Building	Knutt E	12-Feb-99	68-69	X												Schal	
Rip-roaring success	Building	Bingham T	19-Mar-99		X													
Setting the standard	Architect's journal	Evans B	24-Jun-99	55	X												CIRIA	
Share dividend	New Civil Engineer	Thompson R & Russell L	17-Sep-98	20-21	X												CIMsteel, Rowen, Grosvenor Estates, Whitby Bird, Try Construction, Addington	
Standards & Standardisation	New Steel Construction	Pope R	Oct/Nov 98	20-21			X											
Standard Composite Connections	New Steel Construction	Couchman G	Oct/Nov 98	30-31			X											
Standard forms aimed at defeating the cowboys	Building	Barrie G	05-Feb-99		X												Balfour Beatty	
Standard Welds:The last bastion in constructional steelwork connections?	New Steel Construction	Brown D	Oct/Nov 98	32-34			X										SCI	
The £3 billion woman	Construction News	Rogers D	30-Mar-00	1..2	X													
The joy of specs	Building	Bingham T	15-Apr-99		X													
The problem of the scale	Building	Delargy M	03-Dec-99	52-53	X												Gardiner & Theobald, bovis, Ove Arup	
Why surveyors haven't got a clue	Building	Rouse J	?	36-39			X											
Windows on the world	New Civil Engineer	Thompson R & Russell L	17-Sep-98	20-21	X												Bovis	