CIMclad

Computer-Integrated Manufacture of Cladding Systems

"Software evaluation: Arising from industrial deployment"
RAINSCREEN CLADDING

The CIMclad project is specifically focused on “rainscreen cladding” to buildings:

Rainscreen cladding is a layered cladding system typically comprising an outer skin which incorporates air gaps but forms the primary rain barrier, a ventilated air gap that prevents water ingress and an impermeable backing wall.

A more formal project definition of rainscreen cladding follows. This is consistent with the CWCT document “Standard for Walls with Ventilated Rainscreens” and effectively includes the backing wall within the scope of the rainscreen cladding:

Rainscreen cladding is defined as a layered cladding system comprising of:

- A visible outer skin that also forms the primary rain barrier. This causes the majority of water to drain down its surfaces, but does not prevent the passage of air into the air gap.

- An air gap that prevents water ingress into the building. This provides ventilation and, depending on the design and dimensions of the rainscreen and air gap, may be intended to provide pressure equalisation across the outer skin.

- A backing wall that forms an effective air barrier. This typically also provides support to the outer skin, and frequently includes an insulating layer.

Readers should note that within this report the phrase a “rainscreen installation” is used to refer to a specific rainscreen as installed on a specific building.
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The CIMclad project is funded under the Innovative Manufacturing Initiative: Meeting Clients’ Needs Through Standardisation. In addition to the two academic partners, the project involves a significant number of industrial partners. Technical inputs from these and other sources are gratefully acknowledged.

For more details visit the project website: http://www.cae.civil.leeds.ac.uk/current/cimclad
1 Introduction

This report is the sixth in a series of seven reports that are the formal deliverables from the LINK funded CIMclad project. The aim of CIMclad is to investigate the feasibility of improving the efficiency and competitiveness of the cladding sector through the development of a standard framework for computer-integrated design and manufacture of cladding systems. The focus of the project has been on rainscreen cladding.

The previous reports in the series are:
1. Potential for process improvement
2. ICT usage: current and future
3. Review of specifications for rainscreen cladding
4. Formalised performance specification for rainscreen cladding
5. Software deployment scenarios and evaluation criteria

Guided by this initial research and further input from the industrial collaborators, CIMclad focused the subsequent development of a formal product model for rainscreen cladding on the transfer of scheme design information to the detailed design phase. The resulting specifications for this product model (known as the 2D PM) are a major deliverable from the research programme. To enable the industrial collaborators evaluate the 2D PM, the specifications were implemented within prototype software that had been deployed in connection with the industrial partners. The deployment scenarios and the evaluation criteria that had been employed during the trials were reported in Report 5. That report outlined both the 2D PM product model and the prototype software, and presented full details of the deployment scenarios and evaluation criteria for the industrial trials.

The current report presents the role of the evaluation exercise, analyses respondents’ comments, and layout actions in light of the analyses results and draws conclusions.

The final report of the series will be:
7. CIM roadmap for the cladding sector
2 Industrial Deployment

2.1 Objective
As reported in Report 5 the overall objective of the industrial trials is to evaluate the suitability of the 2D PM through deployment of the prototype software on selective simulations of real projects. For this purpose two complementary deployment scenarios were defined, upstream and downstream scenarios.

- An **upstream** is a *scheme design* scenario during which, the prototype software is mainly used to **populate** the 2D PM with the rainscreen context and requirements.
  
  This scenario should involve at least one participant such as an *architect* who can input the rainscreen requirements. Ideally it should also usefully involve a *structural engineer* to input the rainscreen context as a separate task. Additionally, a *rainscreen contractor* could be involved as a consumer of the resulting information at the scheme design stage.

- A **downstream** is a *full design* scenario during which, the prototype software is used to **browse** and understand the rainscreen context and requirements as was defined at scheme design, and to compare these with the current building design.

  This scenario should involve a (different) *rainscreen contractor* as the primary consumer of the information about the scheme design.

2.2 Trial Streams
While the trial should reflect the execution of a real project, it was recognised that (for practical reasons) it may be necessary in some cases for an individual participant to play a role that he does not currently fulfil with his present employer.

Five trial streams were completed as shown in the table below; participation in each stream was driven by the roles that the participants currently do (or can) fulfil. The participants were each asked to complete an evaluation proforma (see Appendix 1), this was done, but the respondents (perhaps inevitably) tended to return a composite response when involved in more than one stream.

<table>
<thead>
<tr>
<th>Trial Stream</th>
<th>Upstream Scenario</th>
<th>Downstream</th>
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<tbody>
<tr>
<td></td>
<td>Architect</td>
<td>Consultant/Structural Engineer</td>
</tr>
<tr>
<td>1</td>
<td>GRA</td>
<td>WBP</td>
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<td>2</td>
<td>CGL</td>
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<td>5</td>
<td>BH</td>
<td>WBP</td>
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Key: WBP = Whitby Bird & Partners  
     GRA = Geoffrey Reid Associates  
     CGL = CGL Cometec  
     BH = Buro Happold
3 Analysis of Responses

An evaluation proforma was devised to allow respondents to make appropriate feedback on their involvement. In the form of an Excel workbook, this proforma comprised three spreadsheets: Respondent Profile, Upstream Scenario and Downstream Scenario (see Appendix 1.)

In defining the industrial trials and the evaluation proforma, emphasis was placed on the overall goal to evaluate the potential of the 2D PM rather than the (easier) task of commenting upon the prototype software. This is reflected in the primary headings that are common to the evaluation sheet for both scenarios:

(A) Relating to the underlying Product Model (2D PM)
   (A1) Existing Scope of 2D PM
   (A2) Effectiveness within existing scope
   (A3) Ease of Navigation
   (A4) Other Comments

(B) Relating to the Prototype Software
   (B1) Usability
   (B2) Function Limitations (within the limited objectives of the 2D PM deployment trials)
   (B3) Desirable Extensions (for production use)
   (B4) Any other Comments

The respondent’s comments are collated in tabular form in Appendix 2. These comments are analysed below in a number of sections. The first section presents a summary of the quantitative responses, the second those comments that can be addressed directly, and the third those comments that can only be indirectly addressed at this time. Within these three sections the text is formatted thus:

- Question posed in Proforma?
- Respondent’s comments.
  Research team’s commentary.
3.1 Quantitative Analysis

In this section, the quantitative responses, on the scale 1 = disagree to 5 = agree, are interpreted.

(A) Relating to the underlying Product Model (2D PM)

(A1) Existing Scope of 2D PM
- Scope appropriate for capturing the scheme design of rainscreen cladding!
  (2; 4; 5; 5; 3) = 3.8
  Most thought the scope was appropriate.
- Within the existing scope, the depth of information is sufficient to adequately capture a scheme design!
  (2; 4; 5; 3) = 3.5
  Most who responded thought the depth of information appropriate.
- The existing scope could usefully be expanded!
  (4; 4; 5; 3) = 4
  Most who responded agreed that the existing scope could usefully be expanded.

(A2) Effectiveness within existing scope
- 2D PM effective in capturing a scheme design!
  (2; 4; 4; 4; 3) = 3.4
  Most respondents agreed that the model was effective within its existing scope.
- 2D PM effective in ensuring the completeness of the captured information!
  (2; 4; 4; 1; 3) = 2.8
  On balance, the 2D PM was not felt to be effective in ensuring the completeness of the captured information.
- The meaning of the required information is clear!
  (2; 4; 4; 3; 2) = 3
  Overall the responses were neutral (which implies the meaning of the required information was not as clear as it should be).

(A3) Ease of Navigation
- The relationships between the forms (i.e. between the 2D PM entities) provide appropriate navigation routes through the information!
  (3; 3; 4; 4; 3) = 3.4
  Overall opinion was weakly in agreement.

(A4) Other Comments
- The granularity with which requirements and properties entities were populated was appropriate!
  (2; 4; 4; 4; 3) = 3.4
  Overall opinion was weakly in agreement.

(B) Relating to the Prototype Software

(B1) Usability
- The prototype was sufficiently usable to be able to judge the effectiveness of the 2D PM!
  (3; 4; 4; 3; 3) = 3.4
  Overall opinion was weakly in agreement.
- The linkage of Access and AutoCAD works effectively!
  (2; 3; 4; 3; 4) = 3.2
  Overall opinion was only weakly in agreement.
3.2 Directly Addressable Comments

This section includes those comments that can be fully addressed (including questions, misinterpretations and clarifications).

(A) Relating to the underlying Product Model (2D PM)

(A1) Existing Scope of 2D PM

- Name any optional attributes that should be mandatory.

  Headings should be added to comply with all sections of the NBS H92. [1]
  
  This is provided for in the requirement entity by the attribute called Aspect, the specifier can populate the Aspect with specification’s appropriate sub-headings. Note that the 2D PM has deliberately not been tied to the requirements of a particular specification.
  
  - Which existing attributes (if any) could be omitted from the current entities?

  Thermal performance is not an issue for rainscreen – that requirement should be a type of cladding performance. [4]
  
  The primary reason for not addressing this within type of cladding performance was to give the possibility of variable requirements across a job reflecting (say) major differences in the backing wall. Thus the U-value is an attribute of backing wall performance, but is only optional for type of rainscreen performance.
  
  - What new attributes (if any) are missing from the current entities?

  Finish of rainscreen panel. [3]
  
  Panel finish is included as an attribute in the Requirement entity.
  
  In the “TypeOfRainscreenCladding” replace PanelMaximumDimension with PanelWidth and PanelSpan [4]
  
  PanelMaximumDimension has a text attribute allowing both width and span to be specified where appropriate.
  
  - Within the existing scope, the depth of information is sufficient to adequately capture a scheme design!

  I’m not sure that all the information in the database is necessary or that all the necessary information is contained within the database but this would depend on what the information is required to do and would appear to be relatively simple to correct once this is established. [5]
  
  We agree on both points. The 2D PM attempts to capture all the information that was identified by the industrial partners, a goal of the current evaluation is to identify where something important was missed (or where something could be omitted).
  
  - How should the scope be increased?

  To include test information. [2]
  
  The attributes enumeration in the requirement entity includes an item for testing.
  
  Generate product models not just for rainscreen cladding but also for all cladding and ultimately the entire building structure [4]
  
  Agreed, but our limited resources required that we be focused to achieve meaningful results.

  The term wind speed should be renamed as wind pressure with wind speed as a requirement. [1]
  
  This is something that was debated at some length during the project, we eventually opted for wind speed. No one else has raised this point.

(A2) Effectiveness within existing scope

- Identify where the meaning of the 2D PM is unclear

  Too much jargon in the terminology – need to simplify the linguistics when discussing entities/attributes/properties [4]
  
  We agree with the sentiment, but some level of formality is needed within a product model in order to avoid ambiguity. This could (and should) be hidden from the end user by production software (but this was not the goal of the prototype software).
  
  - Describe any other 2D PM effectiveness related issues

  Allowable loads on the back up wall form and also thermal resistance seems not to register but this may be rounded down to 0. [1]
  
  This was a software bug that has since been rectified.

  I can see how the 2D PM can work but I don’t quite see the point. Currently the information would be supplied on drawings and the specification. The 2D PM as currently proposed appears to be in addition to these existing sources of information and therefore requires extra effort from the scheme designer but does not have any direct benefit to the cladding designer unless the information can be used directly in the design/manufacture of the cladding. [5]
The aim of the 2D PM is to more closely associate requirements (typically defined in terms of the specifications) with geometry and location (as defined by drawing). It is envisaged that the role of the drawings will be (largely) absorbed into the geometrical capability of the 2D PM (some freestanding detail drawing may still be required). Traditional specifications would still be used, their content being referenced from within the 2D PM (or the applicable clauses replicated within the 2D PM). The current scope of the 2D PM is to capture sufficient information about the scheme design.

(A3) Ease of Navigation

- Describe any other 2D PM effectiveness related issues

Relationship between Access and AutoCAD is not established [1]

This was due to the respondents having unsuitable pre-installed software (was resolved). I found the 2D PM difficult to follow but this is probably inevitable when developing a new system. [5]

Yes, product models have that characteristic and the prototype software deliberately exposed the model! A production implementation would seek to hide the model from the user.

(B) Relating to the Prototype Software

(B1) Usability

- How could the useability of this linkage (between Access and Auto) be improved?

Since I’m using Windows 98 with Access 97 and AutoCAD 2000 it is difficult to say if the current versions are more forgiving. [1]

The prototype software was developed for AutoCAD 2000 and Access 2000. While we managed to make it work partially with Access 97, this version of Access does not provide the support necessary to link correctly with AutoCAD.

(B2) Functional Limitations (within the limited objective of 2D PM deployment trials)

- What are the strengths of the prototype software?

The ability to describe particular section of work. [1]

Agreed.

Allows browser to quickly obtain information and references to engineering standards. [4]

Agreed.

Compatibility across processing and trades. [6]

Agreed.

(B3) Desirable Extensions (for production use)

(B4) Any other Comments

- Relating to the prototype software.

Terms like specification and requirements are confusing [3]

See first response in section (A2).

On the “Building” form there is a reference to “Cladding Performance” but only allows one type to be selected. [4]

This is deliberate. Potentially the 2D PM may be pre-populated with several pre-defined types of cladding performance, but only one of these can be associated with a building. The entity holds things like design wind speed and design life that are (assumed) to be the same for the whole building.
3.2 Indirectly Addressable Comments

This section includes those comments that can be fully addressed because they have implications for the future development of the 2D PM and related software and/or further discussion is required.

(A) Relating to the underlying Product Model (2D PM)

(A1) Existing Scope of 2D PM

- Name any mandatory attributes that should be optional.

The details of rainscreens vary greatly and the specifier can present information in different ways so that it is difficult to say that information should be mandatory. For example if the designer specifies that the design wind load is to be calculated in accordance with BS6399, the cladding designer needs to know information about the site in order to carry out the calculation whereas if the wind load is given in the specification in Pascal this information about the site is not required.

Such variability is recognised, there are two complementary ways of addressing it. One is to capture the underlying business rules within the product model (e.g. if this is specified then that is not required), where appropriate the other is to standardise how things are specified/done within the industry. The overall optimal solution will be some combination of the two, but considerable time and commitment would be required to achieve this goal. Within CIMclad we have tended more towards standardisation because this was central to the EPSRC initiative (Meeting Clients’ Needs Through Standardisation) under which the project was funded. The performance attribute in the Building entity and the Panel Material attribute in the Type Of Rainscreen Cladding entity are to be marked optional [6]

- Noted The first point (make specifying a Type of Cladding Performance optional) appears questionable, the only required attributes are design wind speed and design life and to say nothing about these (in the context of cladding performance) would not be very meaningful. The second point is agreed with since no decision may have been made on panel material – we would favour adding an extra enumeration value “undecided”.

- Name any optional attributes that should be mandatory.

Atmospheric Conditions and Indicative Budget [6].

- Noted (Agree they should be mandatory, but others may find this restrictive)

- Which existing entities (if any) could be omitted?

Rainscreen Corner covered adequately under an edge condition [1]

- Noted (Not sure that this is the case).

Line Visual Feature and Line External Feature entities are to be omitted [6]

- Noted (Why – not needed or not understood?)

- What new attributes (if any) are missing from the current entities?

Air gap should be added as an attribute with ventilation as a requirement [1]

- Noted (Needs clarifying).

- What new attributes (if any) are missing from within the existing scope?

NBS section 370 is important – appearance and fit – not just flatness [1]

- Noted (Relates to Type of Rainscreen Cladding).

- How should the scope be increased?

Specific detail. The monetary value of not having these area specified properly can be significant, with the current route to market with drawings. [1]

Comment not entirely understood, but it may well relate to the first comment in section (B3). Note that specific details (as apposed to indicative details/requirements) would not normally be resolved at scheme design stage.

(A2) Effectiveness within existing scope

- Identify where the meaning of the 2D PM is unclear

Differences between requirement and property and generally filling the same information in different dialogue boxes [1]

Comment understood to be a request only to have one such dialogue box (i.e. combined requirement and property). This suggests that the respondent did not fully appreciate the critical difference between the two in terms of the 2D PM (Requirement = a characteristic that the sought solution should have, Property = a characteristic that the actual solution has), or simply that the prototype software lacked any features that would have reduced the effort required. Also see (A4) comments which imply the latter.

Confusion between 2D in dimensional terms and 2\textsuperscript{nd} layer of information [6]
Comment understood to reflect confusion arising from the title of the 2D PM.
- Describe any other 2D PM effectiveness related issues

Area visual/Line Visual/External feature jargon too complicated and was not used in the stream 1 scenario at Globeside, Marlow. [4]

The comment infers that the feature related entities may have been relevant, but that the entities were not understood.

(A3) Ease of Navigation
- Describe any other 2D PM effectiveness related issues

There should be a vertical scroll bar in Rainscreen Performance box [1]

Noted (And agreed).

(A4) Other Comments
- Consider how this granularity affects the clarity of the information and the future re-usability of entities (via libraries etc).

As mentioned before the order of filling in what amounts to be similar information needs to be addressed. Following on from that the complication of a ‘real’ project and the mass of information needed would make the task daunting. [1]

Appears to relate to the first comment in (A2). This being the case, the underlying problem is that prototype software was used.

Relating to the 2D PM
Following on from the above the complication of a ‘real’ project and the mass of information needed would make the task daunting [1]

Relates to above comment.

There are a large number of input boxes to be completed. In practice it would be tempting to use a copy of a previous job and alter data where necessary. Because of the large number of boxes there would appear to be considerable danger of failing to delete inappropriate entries. This danger applies to all standardised systems but appears to be greater in this approach as the database is less transparent than a paper document. [5]

The observation is correct, although we would see production software employing libraries of types arising from previous projects. This would avoid the danger of leaving inappropriate entities since the library entries would only be inserted into the current project when needed.

(B) Relating to the Prototype Software

(B1) Usability
- How could the usability of the prototype software be improved?

Professional, but some ‘self made’ contractors needing a simple approach in a structured linear direction. [1]

Comment not entirely understood, but seems to be making the valid point that any production software should have the option of being usable at a simplistic level.

Stick strictly to standard Microsoft user interface design conventions. User interfaces need to be much more intuitive. [4]

Noted Agreed, the prototype was implemented using Microsoft tools, but complying with their design guidelines demands much greater resources.

Clear explanation of information and categories. [6]

Noted Agreed, reflects the difference between a prototype and a professional implementation.

- How could the usability of the linkage of Access and AutoCAD be improved?

Useful if you happened to be zoomed to the portion of the drawing where the entity exists, otherwise you have to trawl about for the selected item. [4]

Noted Agreed, this would be a very desirable feature in a production system.

(B2) Functional Limitations (within the limited objective of 2D PM deployment trials)
- What are the weaknesses of the prototype software?

The ability to include drawing details to the extent, which clarifies the spoken word. [1]

Inherently there is no limit to what can be in the AutoCAD file, but the 2D PM information is associated with particular (suitable) CAD entities – representing an extent or a rainscreen area for example. There is no explicit provision in the current 2D PM to associate an (auxiliary) detailed drawing with a textural description.

Language. [6]

Comment not fully understood but assumed to relate to usability rather than to function.
Which single limitation would you most like to see addressed? [1]

The cross-referencing of point of details need to be addressed. This appears to be a restatement of the first comment in section (B2).

Can the information such as area be captured automatically? [2]

Yes, such information is implicitly captured within the geometry of the CAD entity that is used to define the extent (say) of the rainscreen. Thus values such as area could readily be evaluated.

Graphics and pattern explanation. [6]

Comment not fully understood. Graphics and patterns can be included in the CAD, area features provide a means of more formally specifying such requirements.

(B3) Desirable Extensions (for production use)

What are the essential functional additions that would be needed to create an effective production tool?

A specifically devised cross between Access and AutoCAD as an operating system with all self contained functions. [1]

Comment read as meaning that a production tool would more closely integrate the graphical and none-graphical aspects (and may be based on a CAD system) – Agreed.

Interrogation of drawing to generate a bill of parts [4]

This is seen as entirely feasible.

Give your wish list of other added-value functionality that would transform the software into an invaluable applications program.

The ability to relate to a memory bank of project drawings. The descriptive power of drawings in the current ‘Contractor Design’ type of specification can not be ignored [1]

Relates to previous comments.

Can this totally replace specification? [2]

The 2D PM is not intended to replace a specification, but does provide a context within which specifications can be better applied. The ability to define free-standing requirements, in terms of (specification) text or (specification) clause numbers, points strongly to the possibility of libraries of pre-defined specification-based requirements. Such a capability could readily be implemented in software (given the copyright of the specification).

Ability to have intelligence between requirements and choice of available systems, materials [4]

Noted (and agreed). The formality of the 2D PM provides a sound context for incorporating domain knowledge into design tools.

(B4) Any other Comments

Relating to the prototype software.

The in depth study which the project requires: I got the impression that there would be information flowing in all sorts of directions, but I have not [1]

Sentence appears to be incomplete, seems to allude to the amount of work and commitment that is needed to be able to make substantial progress – agreed.
4 Conclusions

The objective of the industrial trials was to evaluate the suitability of the 2D PM to capture and convey information about a rainscreen scheme design, this via the deployment of prototype software on selected simulations of real projects. Five trial streams were conducted and the evaluation has provided the researchers with invaluable information, leading to a better understanding of how the practitioners think. The research team wish to record their thanks to the participants in the trial for their time and their co-operation.

In the three sections that follow we draw conclusions, firstly about the industrial trials themselves and secondly about the strengths, barriers and weaknesses that were identified by those trials.

4.1 Relating to the industrial trials

- The pragmatic devise of some of the participants in the trial opting to play an industrial role (architect, engineer, fabricator, installer, tester, system designer, system fabricator and component supplier) other than that they currently hold appeared to be quite successful.

- The prototype software required AutoCAD 2000 and Access 2000 to be installed on the tester’s PC. Although this requirement was made clear to the industrial partners, many experienced problems using the prototype software only for it to be discovered that they had Access 97 (not 2000) installed on their PC. This resulted in delays and confusion.

- In some cases the individuals who conducted the trials where not sufficiently well briefed. Although comprehensive briefing notes were provided, supplemented by telephone support and visits where appropriate, some of the participants had not been previously been involved in CIMclad and all were probably subject to significant pressure on their available time.

- It was anticipated that the participants would tend to make comments about the prototype software rather than about the 2D PM and, in spite of the instructions and briefing notes, this proved to be the case. The evaluation proforma had been designed to accommodate this difficulty and was relatively successful in separating the two.

- The bigger problem was that the software was a prototype that had been deliberately designed to expose the 2D PM (the objective being to animate the 2D PM and thus enable the participants to populate and to browse the 2D PM entities and their attributes).

- Several of the participants appeared to have little prior knowledge of the 2D PM or of the terminology that it employs. The extent of this problem was a little surprising given that the 2D PM had been presented and discussed several times during project steering committee meetings, was summarised in the briefing notes and the researchers had visited many of the organisations involved in the trials. One consequence is that some of the comments on the 2D PM are devalued. Clearly the solution would have been to hold briefing workshop involving all the actual participants in the trial, but the logistics would have made this infeasible.

- A useful volume of formal feedback was obtained from the participants by means of the evaluation proforma. This feedback is presented within this report and the key points are extracted in the two sections that follow.

- The feedback from the industrial trials confirmed the impression that the researchers had previously formed about different player’s response to the industrial deployment of the 2D PM. Generally the fabricators and rainscreen contractors are in favour, irrespective of the additional advantages of standardised digital information, because of the implicit template it provides for what information should be provided to them. Conversely, the upstream suppliers of this information (such as the Architect) are generally less enthusiastic.
4.2 Identified Strengths
Those strengths that most clearly relate to the 2D PM are at the start of the list; those that most clearly relate to the prototype software are at the end of the list.

- The 2D PM is broadly appropriate for capturing the scheme design of rainscreen cladding, and the existing scope could usefully be expanded.
- The ability to describe particular section of work and capable of providing compatibility across processing and trades.
- The potential to automatically extract derived information from the data within the 2D PM such as schedules and areas.
- The potential to add intelligence between requirements and choice of available systems, materials.

4.3 Identified Barriers and Weaknesses
Those barriers and weaknesses that most clearly relate to the 2D PM are at the start of the list; those that most clearly relate to the prototype software are at the end of the list.

- There is some industrial resistance to the notion of seeking to improve performance through a degree of standardisation of practice.
- There was also resistance to the (incorrect) notion that the 2D PM was intended to replace specifications. When implemented within software, the 2D PM provides a context that enables any (existing) specification to be better applied.
- An unexpected comment, that was raised in several contexts, related to the role of detail drawings. While it is tempting to dismiss this simply as a misunderstanding of the product model based approach, a more considered review of such comments suggests that the underlying point is that diagrams can be more descriptive than words. It is thus proposed that the 2D PM be generalised to enable the association, where appropriate, of sketches with descriptive text.
- A number of users found the more formal language of the 2D PM (e.g. properties, specifications, requirements), which was deliberately exposed by the prototype software, difficult to assimilate. This highlights the underlying fact that moving towards a product model based approach necessitates a degree of cultural change, and this change may need to be more apparent in the scheme design context. That said, the comments made suggested that where a barrier existed it was the lack of understanding of the language as used (rather than any problem with the concepts employed). This comes as no great surprise given the apparent lack of exposure of some participants in the trial, and the prototype nature of the software. However, it does suggest that the authors of the 2D PM need to further develop their glossaries to ensure that appropriate (alternative) definitions of the key terms exist for incorporation into the prompts and help systems of future software implementations.
- A known limitation of the prototype software, the absence of a library capability to minimise the volume of typing required through the re-use of pre-populated entities (from previous projects etc.), was identified in several contexts and compounded other comments. This is clearly something that would be addressed in production software.
- Partly linked to the previous point were comments about the input of quantities of similar information and (more interestingly), the suggestion that while the full flexibility would be required by some, other user may prefer to have a simpler more directed route through the software available.
- Other known limitation of the prototype software, the relatively loose integration of the two environments (CAD and database) and the lack of professional-level Microsoft usability (style of interface and both implicit and explicit help/guidance), were also identified. Again, this is clearly something that would be addressed in a commercial software implementation.
5 Appendix 1: Evaluation proforma

CIM clad: Profile of Respondent

Background of a participant in the trial

Thanks for your time. Please complete electronically (type into the light boxes and shade the heavy boxes as appropriate) or print all three worksheets (select the tabs) and fill in by hand.

(A) Who You Are

Name

Phone

Email

Company

Role within company

(B) Your Profile

Years experience in cladding

Roles experienced (please shade all that apply):

Architect

Engineer

Fabricator

Installer

Testing

System Designer

System Fabricator

Component Supplier

Familiarity with the information relating to a cladding scheme design: Low Medium High

As the creator of such information

As a user of such information

Familiarity with rainscreen cladding

Familiarity with using IT as part of the cladding project delivery process
CIMclad: Upstream Scenario

Effectiveness of 2D PM for capturing the scheme design

(A) Relating to the underlying Product Model (2D PM)

(A1) Existing Scope of 2D PM

<table>
<thead>
<tr>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
</table>

Scope appropriate for capturing the scheme design of rainscreen cladding!

Name any mandatory attributes that should be optional.

Name any optional attributes that should be mandatory.

Which existing entities (if any) could be omitted?

Which existing attributes (if any) could be omitted from the current entities?

What new attributes (if any) are missing from the current entities?

What new entities (if any) are missing from within the existing scope?

Within the existing scope, the depth of information is sufficient to adequately capture a scheme design!

The existing scope could usefully be expanded!

How should the scope be increased?

Describe any other 2D PM scope related issues

(A2) Effectiveness within existing scope

<table>
<thead>
<tr>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
</table>

2D PM effective in capturing a scheme design!

2D PM effective in ensuring the completeness of the captured information!

The meaning of the required information is clear!

Identify where the meaning of the 2D PM is unclear

Describe any other 2D PM effectiveness related issues

(A3) Ease of Navigation
CIMclad software evaluation: Arising from industrial deployment

The relationships between the forms (i.e. between the 2D PM entities) provide appropriate navigation routes through the information!

Describe any other 2D PM navigation related issues.

(A4) Other Comments

The granularity with which requirements and properties entities where populated was appropriate!

Consider how this granularity effects the clarity of the information and the future re-useability of entities (via libraries etc).

Relating to the 2D PM.

(B) Relating to the Prototype Software

(B1) Usability

The prototype was sufficiently usable to be able to judge the effectiveness of the 2D PM!

How could the usability of the prototype software be improved?

The linkage of Access and AutoCAD works effectively!

How could the usability of this linkage be improved?

(B2) Functional Limitations (within the limited objective of 2D PM deployment trials)

What are the strengths of the prototype software?

What are the weaknesses of the prototype software?

Which single limitation would you most like to see addressed?

(B3) Desirable Extensions (for production use)

What are the essential functional additions that would needed to create an effective production tool?

Give your wish list of other added-value functionality that would transform the software into an invaluable applications program.

(B4) Any other Comments

Relating to the prototype software.
**CIMclad: Downstream Scenario**

*Effectiveness of 2D PM for capturing the scheme design*

### (A) Relating to the underlying Product Model (2D PM)

#### (A1) Existing Scope of 2D PM

<table>
<thead>
<tr>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope appropriate for capturing the scheme design of rainscreen cladding!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name any mandatory attributes that should be optional.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name any optional attributes that should be mandatory.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which existing entities (if any) could be omitted?</td>
<td></td>
<td></td>
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<tr>
<td>Which existing attributes (if any) could be omitted from the current entities?</td>
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<tr>
<td>What new attributes (if any) are missing from the current entities?</td>
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<tr>
<td>What new entities (if any) any are missing from within the existing scope?</td>
<td></td>
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<tr>
<td>Within the existing scope, the depth of information is sufficient to adequately capture a scheme design!</td>
<td></td>
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<tr>
<td>The existing scope could usefully be expanded!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How should the scope be increased?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe any other 2D PM scope related issues</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### (A2) Effectiveness within existing scope

<table>
<thead>
<tr>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
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</thead>
<tbody>
<tr>
<td>2D PM effective in capturing a scheme design!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D PM effective in ensuring the completeness of the captured information!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The meaning of the required information is clear!</td>
<td></td>
<td></td>
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<tr>
<td>Identify where the meaning of the 2D PM is unclear</td>
<td></td>
<td></td>
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<tr>
<td>Describe any other 2D PM effectiveness related issues</td>
<td></td>
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</tbody>
</table>
(A3) Ease of Navigation

The relationships between the forms (i.e. between the 2D PM entities) provide appropriate navigation routes through the information!

Describe any other 2D PM navigation related issues.

(A4) Other Comments

The granularity with which requirements and properties entities were populated was appropriate!

Consider how this granularity effects the clarity of the information and the future re-usability of entities (via libraries etc).

Relating to the 2D PM.

(B) Relating to the Prototype Software

(B1) Usability

The prototype was sufficiently usable to be able to judge the effectiveness of the 2D PM!

How could the usability of the prototype software be improved?

The linkage of Access and AutoCAD works effectively!

How could the usability of this linkage be improved?

(B2) Functional Limitations (within the limited objective of 2D PM deployment trials)

What are the strengths of the prototype software?

What are the weaknesses of the prototype software?

Which single limitation would you most like to see addressed?

(B3) Desirable Extensions (for production use)

What are the essential functional additions that would needed to create an effective production tool?

Give your wish list of other added-value functionality that would transform the software into an invaluable applications program.

(B4) Any other Comments

Relating to the prototype software.
6 Appendix 2: Respondents’ collated comments

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>(A) Relating to underlying Product Model (2D PM)</strong></td>
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</tr>
<tr>
<td>(A1) Scope appropriate for capturing the scheme design of rainscreen cladding!</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>(A1) Name any mandatory attributes that should be optional.</td>
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<td>(A1) Name any mandatory attributes that should be optional.</td>
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<tr>
<td>(A1) Name any Mandatory attributes that should be optional.</td>
<td>Heading should be added to comply with all sections of the NBS H92.</td>
<td>-</td>
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<tr>
<td>(A1) Which existing entities (if any) could be omitted?</td>
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<tr>
<td>(A1) Which existing attributes (if any) could be omitted from the current entities?</td>
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<tr>
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<tr>
<td>(A1) What new attributes (if any) are missing from the current entities?</td>
<td>Air gap should be added as an attribute with ventilation as a requirement.</td>
<td>-</td>
<td>Finish of rainscreen panel</td>
<td>In “the TypeOfRainscreenCladding” replace PanelMaximumDimension with PanelWidth and PanelSpan.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>(A1) What new attributes (if any) are missing from the current entities?</td>
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<tr>
<td>(A1) What new attributes (if any) are missing from the current entities?</td>
<td>NBS section 370 is important – appearance and fit – not just flatness.</td>
<td>-</td>
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<tr>
<td>(A1) What new attributes (if any) are missing from the current entities?</td>
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### CIMclad software evaluation: Arising from industrial deployment

#### (A1) Within the existing scope, the depth of information is sufficient to adequately capture a scheme design!

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#### (A1) The existing scope could usefully be expanded!

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<tr>
<td></td>
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<td></td>
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<td></td>
<td>3</td>
</tr>
</tbody>
</table>

#### (A1) How should the scope be increased?

<table>
<thead>
<tr>
<th></th>
<th>Specific detail. The monetary value of not having these area specified properly can be significant, with the current route to market with drawings. [3.3]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To include test information [3.2]</td>
</tr>
<tr>
<td></td>
<td>Generate product models not just for rainscreen cladding but for all cladding and ultimately the entire building structure. [3.3]</td>
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</tbody>
</table>

#### (A1) Describe any other 2D PM scope related issues

<table>
<thead>
<tr>
<th>The term wind speed should be renamed as wind pressure with wind speed as a requirement. [3.3]</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

#### (A2) Effectiveness within existing scope

#### (A2) 2D PM effective in capturing a scheme design!

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<thead>
<tr>
<th></th>
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<th>2</th>
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<th>4</th>
<th>4</th>
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<th>3</th>
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</table>

#### (A2) 2D PM effective in ensuring the completeness of the captured information!

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<th>4</th>
<th>1</th>
<th>-</th>
<th>3</th>
</tr>
</thead>
</table>

#### (A2) The meaning of the required information is clear!

<table>
<thead>
<tr>
<th></th>
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<th>4</th>
<th>4</th>
<th>3</th>
<th>-</th>
<th>2</th>
</tr>
</thead>
</table>

#### (A2) Identify where the meaning of the 2D PM is unclear

<table>
<thead>
<tr>
<th>Differences between requirement and property and generally filling the same information in different dialogue boxes. [3.3]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Too much jargon in the terminology – need to simplify the linguistics when discussing entities/attributes/properties [3.2]</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Contusion between 2D in dimensional terms and 2nd layer of information. [3.3]
| (A2) | Describe any other 2D PM effectiveness related issues |  
|---|---|---
|  | Fastener Allowable loads on the back up wall form and also thermal resistance deemed not to register but this may be rounded down to 0. [3.3] |  
|  | Area visual/Line Visual/External feature jargon too complicated and was not used in the stream 1 scenario at Globeside, Marlow. [3.3] | I can see how the 2D PM can work but I don’t quite see the point. Currently the information would be supplied on drawings and the specification. The 2D PM as currently proposed appears to be in addition to these existing sources of information and therefore requires extra effort from the scheme designer but does not have any direct benefit to the cladding designer unless the information can be used directly in the design/ manufacture of the cladding. [3.2]  

| (A3) | Ease of Navigation |  
|---|---|---
|  | The relationships between the forms (i.e. between the 2D PM entities) provide appropriate navigation routes through the information! |  
|  | Relationship between Access and AutoCAD is not established. [3.2] There should be a vertical scroll bar rainscreen performance box. [3.3] | I found the 2D PM difficult to follow but this is probably inevitable when developing a new system. [3.2]  

| (A4) | Other Comments |  
|---|---|---
|  | The granularity with which requirements and properties entities where populated was appropriate! |  
|  | Consider how this granularity effects the clarity of the information and the future re-useability of entities (via libraries etc). | As mentioned before the order of filling in what amounts to be similar information needs to be addressed. [3.3] |
### CIMclad software evaluation: Arising from industrial deployment

| (A4) | Relating to the 2D PM | Following on from that the complication of a ‘real’ project and the mass of information needed would make the task daunting. [3.3] | - | - | - | There are a large number of input boxes to be completed. In practice it would be tempting to use a copy of a previous job and alter data where necessary. Because of the large number of boxes there would appear to be considerable danger of failing to delete inappropriate entries. This danger applies to all standardised systems but appears to be greater in this approach as the database is less transparent than a paper document. [3.3] | Ok |

### (B) Relating to Prototype Software

#### (B1) Usability

| (B1) | The prototype was sufficiently usable to be able to judge the effectiveness of the 2D PM! | Professional but some ‘self made’ contractors needing a simple approach in a structured linear direction. [3.3] | 3 | 4 | 4 | 3 | - | 3 |

#### (B1) How could the usability of the prototype software be improved?

| (B1) | Since I’m using Windows 98 with Access 97 and AutoCAD 2000 it is difficult to say if the current versions are more forgiving. [3.3] | Useful if you happened to be zoomed to the portion of the drawing where the entity exists, otherwise you have to trawl about for the selected item. [3.3] | 2 | 3 | 4 | 3 | - | 4 |

#### (B1) The linkage of Access and AutoCAD works effectively

| (B1) | The linkage of Access and AutoCAD works effectively | Compatible across processing and trades [3.2] | 2 | 3 | 4 | 3 | - | - |

#### (B2) Functional Limitations (within the limited objectives of 2D PM deployment trials)

| (B2) | The ability to describe particular section of work [3.2] | Allows browser to quickly obtain information and references to engineering standards [3.2] | - | - | - | - | - | - |

| (B2) | The ability to include drawing details to the extent which clarifies the spoken word. [3.3] | - | - | - | - | - | - |

| (B2) | Compatibility across processing and trades [3.2] | Language. [3.3] | - | - | - | - | - | - |
### CIMclad software evaluation: Arising from industrial deployment

<table>
<thead>
<tr>
<th>(B2)</th>
<th>Which single limitation would you most like to see addressed?</th>
<th>The cross referencing of point of details;</th>
<th>Can the information such as area be captured automatically?</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>Graphics and use patterns explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B3)</td>
<td><strong>Desirable Extensions (for production use)</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(B3)</td>
<td>What are the essential functional additions that would needed to create an effective production tool?</td>
<td>A specifically devised cross between Access and AutoCAD as an operating system with all self contained functions</td>
<td>-</td>
<td>-</td>
<td>Interrogation of drawing to generate a bill of parts</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>(B3)</td>
<td>Give your wish list of other added-value functionality that would transform the software into an invaluable applications program.</td>
<td>The ability to relate to a memory bank of project drawings. The descriptive power of drawings in the current ‘Contractor Design’ type of specification can not be ignored; Can this totally replace specification?;</td>
<td>-</td>
<td>-</td>
<td>Ability to have intelligence between requirements and choice of available systems, materials</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>(B4)</td>
<td><strong>Any other Comments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B4)</td>
<td>Relating to the prototype software</td>
<td>The in depth study which the project requires. I got the impression that there would be information flowing in all sorts of directions, but I have not</td>
<td>-</td>
<td>Terms like specification and requirements are confusing [3.2]</td>
<td>On the “Building” form there is a reference to “Cladding Performance” but only allows one type to be selected. [3.2]</td>
<td>-</td>
<td></td>
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</tbody>
</table>