Embedding Building Information Modelling (BIM) within the taught curriculum

Supporting BIM implementation and adoption through the development of learning outcomes within the UK academic context for built environment programmes

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Foreword
This report has been produced by the BIM Academic Forum UK (BAF) core team comprising Doctor Jason Underwood, Senior Lecturer at University of Salford and Director of Construct IT For Business; Professor Farzad Khosrowshahi, Head of School of Built Environment at Leeds Metropolitan University; Steve Pittard of South Bank University; Professor David Greenwood of Northumbria University; and was authored by Tim Platts, Chair of BAF. The project was commissioned by Aled Williams, Discipline Lead (Built Environment) at the Higher Education Academy (HEA) and was carried out in late 2012.

Executive summary
This report considers the impact that building information modelling (BIM) is having on the learning needs of undergraduates and postgraduates; in particular those programmes within the built environment and architectural schools and faculties.

With Government strategy now gathering momentum, developing an informed and equipped workforce is a growing priority. Besides this is the requirement that all higher education institutions (HEIs) respond to changing needs across industry, and although many programmes have begun to recognise this, the need for guidance and consistency has also come into focus. BAF was established in late 2011 to respond to these needs and now includes the vast majority of HEIs with an interest in this area. The opportunity to build upon the original work of the group, particularly around articulating learning outcomes, and to share information was further enhanced by a HEA-funded interactive workshop at the University of Salford, November 2012.

The main purpose of the workshop was to:

a) provide opportunity for the candidates to hear the latest strategic developments from the Government BIM team from David Philp – Head of BIM Implementation for the Cabinet Office;
b) provide opportunity for the candidates to gain an insight into the work of the training and education task group and to consider the definition of outcomes of the National Occupational Standards (NOS);
c) work in peer groups to explore and determine definitions for learning outcomes at level 4, 5, 6 undergraduate and level 7 postgraduate programmes.

In addition, some key findings from the workshop evolved which fell into the following main categories, and from these this report considers its conclusions and recommendations:

- up-skilling of staff to support the delivery of the desired learning outcomes;
- student employability;
- framework for learning;
- keeping pace with the development of BIM.

“At this point in the evolution of the UK BIM strategy it is of increasing importance that our teaching institutions are equally well informed of the progress that is being made across those Government departments which are spearheading implementation on projects and across its asset base. The BAF has taken great steps by bringing together and providing a focus for UK academia. The agenda supports that of the BIM task group in promoting UK BIM adoption and leadership both home and abroad to ensure that the UK is at the vanguard on new, more efficient ways of working” Professor David Philp, Head of BIM at Mace, currently seconded in the Cabinet Office as Head of BIM Implementation
Introduction – background to the introduction of BIM

Over recent years, the attention that building information modelling (BIM) has been receiving has been steadily growing, and this has been substantially increased through the Government’s intervention, with its BIM Report and Government Construction Strategy (GCS) both published in 2011. The impact of these two documents on the industry has been significant and ultimately will lead to all public sector departmental spending being channelled through a supply chain which is BIM ‘level 2’ compliant. Indeed, the Government has mandated that all public procured projects are to be delivered through, by or with BIM by 2016. The ubiquitous Bew-Richards maturity diagram (noted in the reports mentioned above and included in this report at Appendix 2) defines ‘level 2’ as file-based collaboration and library management. The purpose behind the Government ‘push’ at this time is in order to derive significant improvements in cost, value and carbon performance, as has been cited by the industry for some time (see Latham (1994), Egan (1998), Wolstenholme (2009), Andrews, et al 2009). In addition to the challenge of up-skillinthe current work force, this has significant implications for higher education in developing future built environment professionals with the necessary skills to work in new ways, beyond their traditional disciplines. Alongside this, it is recognised that there will be a need to work with the professional institutions in addressing new requirements in the accreditation of courses. Altogether this provides the construction industry with its greatest challenge and opportunity to revolutionise working practices with the aim of increasing productivity and efficiency. The GCS proposes that its recommendations, which include BIM alongside a call for greater collaboration and new contract formats, should lead to savings targeting 20% of both capital and operational budgets. Further information and reference sources are provided at the end of this report.

Currently there is very little regulation directly relating to the production and use of information relating to BIM in the UK. Much of the early momentum in respect of the approach, relevant standards and research has emanated from the US and is revealed in output such as that produced by the American Institute of Architects (AIA), ‘consensus docs’, Construction Operations Building Information Exchange (COBie) and the dominance of the world’s leading vendor for BIM authoring software, Autodesk. The effect of technology providers and software vendors is also a key matter in the formulation of BIM strategy and indeed learning, which needs careful consideration. The UK Government’s position in relation to these matters has been to be non-prescriptive and adopt a software neutral position, while its governance and guidance leaves the detail for delivering the outputs and outcomes it is demanding to the supply chain itself.

In 2011 the UK Government established its BIM Implementation team whose articulation of the process and promotion of the benefits of BIM within Government departments has had a great impact, and its influence continues to grow. From setting the agenda in the 2011 report, a number of task groups have been set up each of which seeks to address a specific area or topic related to the adoption and implementation of BIM. This includes the training and education task group which has had representation covering the HEIs, training organisations and bodies such as construction skills and Construction Industry Council (CIC).

As a result, the amount of information and data, and general progress being made in supporting BIM implementation in the UK is rapidly increasing with UK standards guides (e.g. Building Information Mode (BIM) Protocol, Standard Protocol for use in projects using Building Information Models, CIC 2013) either produced and available under free licence or imminent in release through the B/555 Technical Committee Roadmap. It is against this backdrop that BAF
has been established and seeks to provide a co-ordinated and integrated response from the higher education sector.

**BIM Academic Forum UK (BAF)**
The BIM Academic Forum (BAF) is a group of representatives from a large number of UK universities formed to promote the academic aspects of BIM. In particular, BAF is focused on the development of a ‘BIM academic framework’, the aim of which is to propose a roadmap towards a longer-term vision of embedding BIM learning at the appropriate levels within ‘discipline-specific’ undergraduate and postgraduate education. This would facilitate the development of professionals with the relevant BIM knowledge considered necessary. Moreover, BAF has begun to breakdown and establish the potential learning outcomes requirements at levels 4-7 of HEI education.

BAF has over 55 members from 30 teaching centres across the UK and includes representation from the Republic of Ireland. Formed in late 2011, it operates under the following values and principles:

**VISION**

*To foster integrated collaborative working on projects over the lifecycle of the asset through academic involvement and enhancement of BIM.*

**MISSION**

*To create a dynamic group to develop and promote the training, learning and research aspects of BIM through strong collaboration and co-operation.*

**OBJECTIVES**

- focus on and elevate the training and learning and research aspects of BIM;
- collective promotion of BIM (expand wider market not extend own market);
- establish open medium for communication thus sharing knowledge, experience, case studies, views, etc.;
- collaboration for joint activities and research projects;
- collective voice in both teaching and learning and research matters, so to contribute to policy issues, funding priorities and agenda setting;
- attempt to minimise duplication and create standard practices while celebrating diversity.

BAF has met on several occasions and held meetings to formulate and develop the BIM academic framework UK (see Appendix 1) which seeks to provide a graphical presentation of the requirements at undergraduate and postgraduate level along with the relationship to the vocational training being led by the Government’s BIM task group on training and education and the professional institutions, e.g. including Royal Institute of British Architects (RIBA), Chartered Institute of Building (CIOB) and Royal Institution of Chartered Surveyors (RICS). This approach has been interrogated by the group and has stood up to the tests applied to it to date. It is therefore considered a robust articulation of the needs for and purpose of BAF.

The BAF membership is noted in Appendix 4
Development workshop
Discussions with HEA led to the proposal for a funded workshop whose focus it was to present the initial work of BAF in terms of the BIM academic framework and the initial outcomes of previous working group sessions (e.g. Loughborough, June 2012) to a wider audience and also to facilitate further development of the framework and the associated learning outcomes. Representatives from some 20 HEIs, noted below, participated in the workshop held at University of Salford, 26 November 2012.

Figure 1: Location of partner institutions across UK

By bringing together interested academics from across the UK, the opportunity to brief delegates on Government strategy was achieved through the involvement and contribution at the event from Cabinet Office representatives and the BIM task group for training and education. The initial sessions were delivered by David Philp, Head of BIM Implementation and David Cracknell, Director of Skills & Lifelong Learning, Construction Industry Council.

Key Messages from the Presentations
Together, David Philp and David Cracknell provided the group with a complete and up-to-date overview of current policy and how this is evolving, in particular and of significance was the statement that UK construction industry now ranks second behind Finland in leading the implementation of BIM in terms of infrastructure spend. Other aspects of the presentations that are useful to include and note in summary in this report are:

- function of the Cabinet Office is to set BIM policy; Department of Business, Innovation, and Skills (BIS) to support BIM growth; and CIC to ensure engagement;
- role is to create the ‘intelligent client’ thus establishing the ‘pull’ equals purpose driven BIM, through defining the data it wants to buy;
• part of the journey necessitates behavioural change, thus engaging the social sciences;
• traditionally, customers not getting the outcomes they needed/wanted; BIM is able to deliver performance predictability for the client, and for the supply side to attain new efficiencies;
• BIM ‘supply side’ group established with this focus alongside other working groups targeting retail, private sector, rail and small, medium sized enterprises (SMEs);
• project life cycle now being articulated through ‘data drops’ using COBie as its common language;
• the introduction of employer information requirements is seen as key a part of the processes that are to be defined in the burgeoning output from Government relating to standards, protocols, definitions and contracts;
• the role of the information manager is now evolving;
• all aimed at securing the right amount of data at the right time.

Initial BIM learning outcomes framework – David Cracknell:

“The framework covers three levels of need: strategic, management and technical… the framework endeavours to interpret broad outline headings (resulting from the initial review of BIM learning needs for Government departments) into learning outcomes. These consist of a stem statement followed by a series of more detailed outcomes taken from the titles of relevant current sector National Occupational Standards. This will hopefully help to give substance to each area and focus on the various functional contexts in which the learning can be applied.

At the moment the term ‘understand’ is used in each of the learning outcome stems. This is partly because what is proposed is a short course that may not allow for going beyond basic understanding. However, it is quite possible to alter this stem learning verb to indicate a different depth of learning or different emphasis e.g. ‘apply’ ‘evaluate’ etc. Each of the three level frameworks incorporates the overarching BIM introduction learning outcome”

An extract from the framework is included in Appendix 5 for illustration purposes. This will be available from the BIM task group website (http://www.bimtaskgroup.org/education-and-training/).

Teaching possibilities

The way in which BIM can be taught and the impact BIM could have on teaching was considered by Aled Williams in his presentation. Clearly there is a broad spectrum of possibilities covering the following aspects:

• the technology;
• language used;
• approach adopted;
• pedagogy.

Each HEI will need to consider its own approach in light of a number of factors, not least how far BIM is currently embedded within its curricula. Where HEIs are considering implementing BIM in their modules, the BIM teaching impact matrix noted below can be used as an aid to determining the optimum requirements.
### Figure 2: BIM teaching impact matrix

<table>
<thead>
<tr>
<th>BIM Level:</th>
<th>Absent</th>
<th>Aware</th>
<th>Infused</th>
<th>Embedded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIM descriptor</strong></td>
<td>BIM is a nice research area but should not affect what and how we teach. Our students do not need to know about BIM.</td>
<td>BIM is a nice research area but should not affect how we teach. Our students should be aware of BIM and how it might impact their future.</td>
<td>Students should understand how BIM will affect their future and have chance to learn BIM in a discipline &amp; multi-disciplinary context.</td>
<td>BIM is so important it should become the ‘vehicle’ for our students’ learning experience. Teaching should enabled by the BIM model.</td>
</tr>
<tr>
<td><strong>Curriculum</strong></td>
<td>No change</td>
<td>Key modules are identified and BIM knowledge incorporated.</td>
<td>Target modules identified for a BIM review. BIM impact identified in all areas of the curriculum but BIM use restricted to a few.</td>
<td>Full curriculum review to allow every module to identify changes required for delivery through a BIM model.</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>No change</td>
<td>No change</td>
<td>Structural review needed but impact on current structure likely to be minimal.</td>
<td>A complete review of structure to enable the BIM model to be the driver/vehicle for learning.</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td>No change</td>
<td>Staff in the key modules will need an understanding of BIM and how it impacts industry.</td>
<td>All staff require knowledge of BIM and how it is impacting industry. Some staff need full competence in use of BIM.</td>
<td>All staff would need to be fully competent in the use of BIM and understand how BIM is impacting on the industry.</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>No change</td>
<td>No change</td>
<td>Significant investment required. BIM labs needed and some delivery space suitable for BIM enabled learning.</td>
<td>Significant investment in infrastructure required. BIM labs and delivery space sufficient for BIM being the learning vehicle.</td>
</tr>
<tr>
<td><strong>Curriculum - Research gap</strong></td>
<td>Can be large</td>
<td>No change</td>
<td>Has to be small in some areas but with some flexibility.</td>
<td>Has to be small for all areas of the curriculum. Genuine integrated direction between research and curriculum/delivery.</td>
</tr>
</tbody>
</table>

(Williams and Lees, 2009)
Group work

The remainder of the workshop focused on the delegates views and opinions of the necessary learning outcomes required at levels 4, 5, 6 (undergraduate) and 7 (postgraduate) programmes of higher education in the built environment. This covered the following disciplines represented by the various HEIs attending the workshop:

- construction management and construction project/design management;
- architectural technician/technologist;
- building services engineering;
- quantity surveying;
- architecture;
- civil engineering;
- BIM Masters programmes (i.e. at Salford and Northumbria).

Following the breakout sessions, each workgroup presented their results to the whole workshop which are covered below:
Figure 3: Presentation of learning outcomes from workshop group sessions

<table>
<thead>
<tr>
<th>Level</th>
<th>Knowledge and understanding</th>
<th>Practical skills</th>
<th>Transferable skills</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Undergraduate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>• importance of collaboration</td>
<td>Introduction to technology used across disciplines</td>
<td>BIM as a process/technology/people/policy</td>
</tr>
<tr>
<td></td>
<td>• the business of BIM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>• BIM concepts – construction processes</td>
<td>• use of visual representations</td>
<td>• value, lifecycle and sustainability</td>
</tr>
<tr>
<td></td>
<td>• stakeholders’ business drivers</td>
<td>• BIM tools and applications</td>
<td>• ‘software as service’ platforms for projects</td>
</tr>
<tr>
<td></td>
<td>• supply chain integration</td>
<td>• attributes of a BIM system</td>
<td>• collaborative working</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• communication within inter-disciplinary teams</td>
</tr>
<tr>
<td>6</td>
<td>• BIM across the disciplines</td>
<td>Technical know how:</td>
<td>Process/management:</td>
</tr>
<tr>
<td></td>
<td>• contractual and legal frameworks/regulation</td>
<td>• structures and materials</td>
<td>• how to deliver projects using BIM</td>
</tr>
<tr>
<td></td>
<td>• people/change management</td>
<td>• sustainability</td>
<td>• information and data flows</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• BIM protocols/EIR</td>
</tr>
<tr>
<td></td>
<td><strong>Postgraduate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>• collaborative working, BIM, information management and its application in the built environment</td>
<td>• demonstrate ability to adopt different platforms</td>
<td>• project level application</td>
</tr>
<tr>
<td></td>
<td>• commercial implications – contractual/legal etc</td>
<td>• critically judge/evaluate various BIM tools/applications</td>
<td>• cross discipline and team working</td>
</tr>
<tr>
<td></td>
<td>• de-risking projects through BIM and risk management</td>
<td>• protocols/inter-operability/standards</td>
<td>• importance of effective communication and decision making – human interaction!</td>
</tr>
<tr>
<td></td>
<td>• understanding nature of current industry practice</td>
<td>• capability evaluation</td>
<td>• process mapping and BPR</td>
</tr>
<tr>
<td></td>
<td>• client value – soft landings</td>
<td>• change in way projects are to be delivered</td>
<td>• change management and cultural gap</td>
</tr>
<tr>
<td></td>
<td>• business value – ROI/value proposition</td>
<td>• visualisation of large data sets</td>
<td>• masters level thinking – strategic/technical/managerial</td>
</tr>
<tr>
<td></td>
<td>• understanding supply chain management</td>
<td>• lean principles and links to BIM</td>
<td>• ability to assess barriers to BIM at various levels e.g. corporate/project</td>
</tr>
<tr>
<td></td>
<td>• lifecycle management of BIM – asset, performance in use etc</td>
<td>• use of BIM enabled technology e.g. palm devices</td>
<td></td>
</tr>
</tbody>
</table>
Summary

Level 4 (year one of undergraduate study): essentially, the key learning outcomes at this stage are to provide the context and background to the industry, and why the need for significant productivity improvements exists, set against the historical and traditional working arrangements which have prevailed. This will cover an appreciation of how the industry works, the key roles and disciplines involved in delivering projects and identify the nature and role of the various stakeholders. It should also include an introduction to the way in which information is prepared, shared and issued and also to the technologies being employed to support BIM and promote collaborative working.

Level 5 (year two): outcomes here aim to develop the knowledge and understanding of the role of BIM as a business driver for collaborative working within an integrated supply chain, considering the roles and responsibilities of each within a BIM approach. Students should be able to investigate and articulate the value proposition for BIM from the perspective of each party and consider the impact of BIM in terms of life cycle and whole life cost on projects.

Level 6 (year three and potentially after year out in industry): at this level there should be a greater focus on building competence and knowledge around the people, systems and process which are required for BIM to be delivered successfully on projects. This should include the ability to fully articulate the benefits of BIM. There should be awareness and appreciation of the cultural and organisational impacts of change necessary for the adoption of BIM both people issues and practical issues; awareness required of the practical measures necessary for BIM implementation including understanding of available technologies, means for exchanging data, standards and protocols; and appreciation of new ways of working in groups/projects—integrated project team work and collaborative working environments to support BIM delivery.
Key findings

Beyond the core learning outcomes in relation to knowledge and understanding, practical skills and transferable skills, key findings from the workshop note the need for up-skilling of staff, student employability, and a framework for learning.

Up-skilling of staff

While the industry itself is faced with a substantial steep learning and training programme, the HEIs need also to contemplate how they can ready themselves to deliver a programme of learning and study that is BIM aware, BIM focused and BIM enabled. To date most HEIs have relied on basic training of the technology and its functionality, which at best represents only the most fundamental aspects of BIM, and does not, in itself, support the knowledge and understanding (as noted below) required by the push for BIM adoption and in particular the recommendations of the Government Construction Strategy (2011). This matter, therefore, obscures the need for greater staff awareness and exposure to BIM methodologies so as to be able to articulate the changes clearly needed and acknowledged by industry in order for BIM adoption and implementation to succeed. A crucial factor to this up-skilling requirement is greater collaboration, contribution from, and participation of industry with academia. Some great examples of such knowledge exchange forums already exist, e.g. BIM Academy at Northumbria University, thinkBIM at Leeds Metropolitan University, and The Learning Xchange at the University of Salford. The opportunities presented by the formulation of the CIC sponsored regional BIM hubs is to be noted and not to be underestimated. CIC has been tasked with setting up a network of BIM regional hubs to help ensure that the most up-to-date and consistent information on the UK Government level 2 BIM programme is disseminated across the UK and allowing for a local feedback mechanism to the Government BIM task group at a grass roots level.

Student employability

HEIs are already experiencing the demands from industry for BIM-ready graduates, i.e. those capable of articulating the benefits of BIM; able to use aspects of the technology relevant to their discipline; aware of the challenges imposed by existing methodologies; and capable of delivering change. The increasing awareness of BIM across industry will drive this demand exponentially and the response from academia will be tested. While the broader industry awareness and appreciation of BIM is still largely in its infancy, the larger firms both in contracting and consultancy have already embraced the benefits of BIM and most have a BIM strategy at the heart of their operations. The introduction of a specific BIM4SME group aimed at the small and medium enterprises mainly found in tiers two and three in the supply chain (those specialist sub-contractors and sub-subcontractors). This heralds the championing of this sector of the industry and their important and crucial role in fully embedding BIM throughout the process. This will include not only the smaller contractors and consultants, but also manufacturers and specialist suppliers/contractors. Hence, the reach of BIM and the need for this to be reflected in the graduating cohorts’ innate skill sets is likely to become critical within the next few years. Most software vendors provide free student licences, although hardware demands may be a factor is ensuring there is provision at the necessary level. The opportunity provided by the relationship already formed between BAF and the BIM task group, alongside the growing involvement of CIC should allow a seamless and quick integration of the necessary steps and guidance, to ensure such provision is made widely available.
Framework for learning

A framework for learning which provides a non-prescriptive yet overarching template that can be configured and adopted for a wide variety of purposes will allow HEIs to move forward quickly and confidently. This will rely upon the early adopters of BIM sharing some of their knowledge for the benefit of the many – and the pay back must have to be greater collaboration between the HEIs themselves leading to benefits in terms of networking, knowledge exchange, reciprocation and joint research. Further analysis of the needs at each learning stage covered includes:

- providing wider industry context and background relating to the introduction and implementation of BIM in the first stages of study;
- greater collaboration across the disciplines; use and adoption of the technology;
- realising the impact on project/business structures, communications and behaviours.

Within the detail of the response to learning outcomes at each stage it became apparent that the best way to approach the learning requirements would be to categorise these by/as:

- knowledge and understanding;
- practical skills;
- transferable skills.

The presentation of material for each level resulting from the working groups has therefore been represented in this way, leaving only those residual issues that need to be considered by each provider, and which is likely formulate the ongoing agenda for BAF.

Keeping pace with BIM development in IT and industry

The increasing volume of output and information relating to BIM in industry and academia will lead to an additional challenge for the HEIs and in response to this given the feedback provided by delegates at the workshop, the need for greater communication and collaboration between academics needs to be recognised. This provides BAF with an ongoing mandate to act on behalf of the stakeholders and to improve its offer through a more regular agenda, planned events, communication platform and sharing of knowledge and information, thereby meeting its aims and objectives as noted in its terms of reference (see the section headed BAF above). The construction industry is not the only sector undergoing change and challenge, nor is the technology surrounding BIM of any great significance beyond providing highly functional and efficient tools, but the need to reflect on the impact in other areas such as business, engineering and IT has been identified by this study group.

As mentioned earlier in the report the relationships fostered throughout 2012 with the BIM Implementation team leaders and the training and education task group in particular, along with the need to ensure full and proper representation with CIC, is a fundamental requirement in moving forward with the higher education agenda. Given the broad representation of the current group, the robust testing and interrogation of the BIM academic framework, and the emerging articulation of learning outcomes, it is now necessary to alert the professional institutions to the work and effort that has been undertaken and to seek closer collaboration in 2013 to ensure that such effort is not duplicated.
Conclusions
The workshop and group work at the event facilitated by HEA with University of Salford has provided an important step in the evolution of determining the learning outcomes at various levels within the undergraduate and postgraduate related programmes, alongside the broader dissemination of information within a larger representative group. This builds the resilience of the BIM academic framework process, and provides opportunity for this to be shared with a larger audience and broader stakeholder groups.

The information prepared by BAF and developed through 2012 alongside the workshop output, which articulates the high-level learning outcomes at each stage within the relevant programmes, provides the basis for each institution to begin to map its own content.

This report should provide a firm basis for understanding the impact of BIM and the opportunities this presents to those in higher education, together with an understanding of why this needs to be undertaken and how this can be done.

It further establishes the work of BAF and the need for this to continue against the original doctrine, as well as endorsing the work and output to date. The ability for BAF to act as hub to receive, co-ordinate and act upon information and suggestions from its member/member institutions should be well noted, and its growing importance respected. Hence the continued growth and development of its work and membership is seen as both necessary and worthy.

As a result of the workshop, and the output from it, a report has been prepared for wider dissemination, in particular aimed at the professional institutions, which for now have been targeted through the CIC BIM forum (see Appendix 3).

Recommendations
Head of BIM Implementation for the Government and speaker at the workshop David Philp, offered BAF the use of a page on its website to be dedicated to BAF. This would not only provide a valuable communication and information tool but also ensure that anyone searching for BAF is able to view and access the wealth of other information that exists on the website which is expanding all the time. It is also to be noted that a large proportion of ‘hits’ to the website are international. It is recommended that this offer be accepted and the webpage be developed.

The level of output and work produced as a result of the workshop funded by HEA with University of Salford establishes some key outcomes which are sufficiently developed to be shared with other key stakeholders, in particular, the main professional institutions associated with this sector including RIBA, CIOB, RICS, Institution of Civil Engineers (ICE) and Chartered Institute of Architectural Technologists (CIAT). The purpose of the approach at this stage is to ensure that the institutions are aware of BAF and its purpose and, through close collaboration and co-operation, future thought processes and work in this area can be aligned for mutual understanding and benefit.

Further work is required to develop the high-level outcomes identified by this workgroup and to add necessary detail. Such detail is indicated in the forthcoming publication of the BIM training and education task group’s initial BIM learning outcomes framework. Further HEA funding should be considered in order to release this level of detail and to ensure that, via BAF, the sharing of this knowledge is achieved across UK academia.
References


Web links

HM Government BIM Task Group main website http://www.bimtaskgroup.org/

AEC UK CAD and BIM Standards Site - http://aecuk.wordpress.com/

American Institute of Architects - http://www.aia.org/

Construction Industry Council website http://cic.org.uk/
1. The purpose of the BIM academic framework (depicted) is to propose a roadmap towards a longer-term vision of incorporating BIM learning at the appropriate levels within ‘discipline-specific’ undergraduate and postgraduate education that facilitates the development of professionals with the relevant BIM knowledge considered necessary.

2. In the first instance, the framework depicts the process of translating the work being undertaken by the Government BIM training and education task group to develop a skills capability/competence matrix into establishing consistent and comprehensive BIM-related learning outcomes at the various levels of undergraduate and postgraduate discipline-specific programmes. In this way, it is proposed that BIM-related knowledge is progressively developed at an appropriate level and in line with the discipline-specific knowledge development within programmes. Furthermore, these BIM-related learning outcomes, and individual institutionally developed course materials, can also be informed through their research activities.

3. It is proposed that such BIM-related outcomes described above should also facilitate informing the relevant industry professional institutions towards establishing the required BIM-related accreditation criteria and therefore the accreditation requirements for undergraduate/postgraduate programmes.

4. From the professional development perspective, the work being undertaken by the Government BIM training and education task group will inform the CPD aspect of the professional bodies, which in turn, informs their accreditation criteria.
Appendix 2: Bew-Richards maturity diagram
Appendix 3: Briefing note to professional institutions

From BIM Academic Forum December 2012

Key points
- BIM Academic Forum UK formed in 2011 to promote collaboration and co-operation across higher education institutions;
- academic framework evolved in 2012 and articulation of learning outcomes being developed;
- 60 members from 29 institutions;
- HEA funded workshop and report due June 2013;
- Need identified for communication and alignment with professional institutions.

Background
The surge of interest in BIM, in particular the commitment shown by Government, highlights the need to visit BIM concepts within the taught curriculum in undergraduate and postgraduate programmes across UK academia. In December 2011 representatives from eight UK universities and a technology organisation formed the BIM Academic Forum (BAF) to promote the academic aspects of BIM. From inception the forum enjoyed a high degree of commonality in terms of thinking and approach. It was also agreed that the focus of the group would be on issues pertaining to teaching and learning as well as research. While it was recognised that the work of the forum would be inspired by the needs of the industry, the aspiration of the group would be focused on developing student competence in BIM concepts as well as generating BIM-related new knowledge through research.

It is recognised that the research aspects are themselves governed by the nature of the funding opportunities many of which may fall under applied areas. It is also recognised that BIM issues may appeal to academic disciplines peripheral or outside built environment.

The terms of reference are identified as follows:

Vision
To foster integrated collaborative working over the lifecycle of the asset through academic enhancement of BIM.

Mission
To create a dynamic collaborative group to enhance and promote the teaching, learning and research aspects of BIM.

Objectives
- focus on and elevate the training and learning and research aspects of BIM;
- collective promotion of BIM;
- establish open medium for communication and sharing knowledge, experience, case studies, etc.;
- collaboration for joint activities and research projects both in UK and international;
- collective voice in both training and learning and research matters, so to contribute to policy issues, funding priorities and agenda setting;
- attempt to minimise duplication of effort, and create standard practices but celebrate diversity.
Since these principles have been established and enshrined in the BAF terms of reference document, which each institution endorses, the forum has met on a number of occasions. Meetings held in Leeds, Salford and Loughborough were held throughout 2012 to drive collaboration and co-operation between organisations. This included sharing the BIM academic model formulated originally between Salford, Leeds Metropolitan and South Bank universities as noted in Appendix 1, and to begin identifying common learning outcomes at the various learning stages and levels on related programmes.

Most recently the group, which now numbers 60 members and covers the centres detailed on the map in Figure 1, obtained HEA funding to host and run a workshop to expand on this work and capture the data and information in a formal report. This was held at the end of November 2012 at Salford and included presentations from BIM Implementation task group (David Philp) and Training and Education working group (David Cracknell/CIC), followed by structured working sessions focusing on the learning outcomes for each stage of learning. The delegates attending the event represented programmes in the ‘built environment’ field including quantity surveying, construction management, architecture, architectural technology and project management at undergraduate and postgraduate level. Currently the BAF leadership team comprises

- Professor Farzad Khosrowshahi, Leeds Metropolitan University;
- Steve Pittard, South Bank University;
- Tim Platts (Chair);
- Professor Jason Underwood, University of Salford;
- Professor David Greenwood, Northumbria University.

Figure 1 – BAF member institutions
Outcome of workshop

One of the initial key outcomes from the HEA Salford workshop has been the identification of high-level learning outcomes at each level within university provision. The resulting report will also identify further key points from the discussion and debate on the day and will be available from June 2013.

Next steps

The BAF leadership team wish to see engagement between the activities of BAF and the educational teams within each of the professional institutions including, but not limited, to RICS, CIOB, RIBA, CIAT, Chartered Institution of Building Services Engineers (CIBSE), etc. The aim is to be able to create a direct link between the organisations in order initially to secure:

- clear lines of communication to ensure that activity is co-ordinated and duplication of effort avoided;
- provide a suitable platform to share information, inputs and outputs which augment the effort and activity currently being undertaken and envisaged in the future;
- promote collaboration to see that all parties benefit from the most informed and up to date information and thinking with regard to BIM;
- engender close co-operation and appropriate use of resources to be able to make substantial gains in the shortest possible timeframe.

The purpose of this briefing note is to communicate the existence and work of BAF and to begin the collaborative effort necessary to prepare an integrated and co-ordinated plan for the delivery BIM across the relevant programmes of study.
### Appendix 4: List of members

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Name</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Nooshin Akrami</td>
<td>University of Bolton</td>
<td>Energy Maradza</td>
<td>University of Reading</td>
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<td>Anas Bataw</td>
<td>University of Manchester</td>
<td>Ramesh Marasini</td>
<td>Solent University</td>
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<td>Mark Bew</td>
<td>BIS</td>
<td>Diane Marsh</td>
<td>Liverpool John Moores University</td>
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<td>Paula Bleanch</td>
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<td>George Martin</td>
<td>Coventry University</td>
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<td>Claire Bowles</td>
<td>Leeds Metropolitan University</td>
<td>Malachy Mathews</td>
<td>Dublin Institute of Technology</td>
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<td>Ezekiel Chinyio</td>
<td>University of Wolverhampton</td>
<td>Adam Matthews</td>
<td>Autodesk</td>
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<td>David Cracknell</td>
<td>ClC</td>
<td>George Mokhtar</td>
<td>BIM Academy</td>
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<tr>
<td>Nashwan Dawood</td>
<td>Teesside University</td>
<td>Jim O’Connor</td>
<td>Galway Institute of Technology</td>
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<td>Peter Demian</td>
<td>Loughborough University</td>
<td>David Philip</td>
<td>BIS/Cabinet Office</td>
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<td>Ray Elysee</td>
<td>University of Huddersfield</td>
<td>Steve Pittard</td>
<td>London South Bank University</td>
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<td>Andrew Platten</td>
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<td>David Greenwood</td>
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<td>Aimie Rimmington</td>
<td>Nottingham Trent University</td>
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<td>Michael Greenwood</td>
<td>University of Greenwich</td>
<td>Kirti Ruikar</td>
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<td>Patrick Thornhill</td>
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<tr>
<td>Farzad Khosrowshahi</td>
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<td>Antony Thorpe</td>
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<td>Arto Kiviniemi</td>
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<td>Jason Underwood</td>
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<td>Tahar Koudier</td>
<td>Robert Gordon University</td>
<td>Jennifer Whyte</td>
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<td>Richard Laing</td>
<td>Robert Gordon University</td>
<td>Aled Williams</td>
<td>HEA</td>
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<td>Geoff Levermore</td>
<td>University of Manchester</td>
<td>Bimal Kumar</td>
<td>Glasgow Caledonian University</td>
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<td>Steve Lockley</td>
<td>Northumbria University</td>
<td>David Boyd</td>
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<tr>
<td>Priti Lodhia</td>
<td>The College of Estate Management</td>
<td>Poorang Piroozfar</td>
<td>University of Brighton</td>
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Appendix 5: Initial BIM Learning Outcomes Framework

Extract for illustration purposes only

STRATEGIC
Overview
In relation to each of the learning outcomes below, as a result of following this course, individuals will be expected to:

O1 What is BIM
Understand the principles of Building Information Modelling and its application to the whole life inter-disciplinary design, construction and use of building and infrastructure developments

O2 BIM value proposition (context relevant e.g., client and contractor)
Understand the value proposition that BIM offers enabling adopters to more efficiently:
- Identify and evaluate stakeholder, user, community and sustainability project requirements
- Prepare project briefs and development programmes
- Assess and manage project risks and opportunities
- Prepare and present project design recommendations
- Assess, plan, estimate and control proposed development energy, whole life and capital costs etc

MANAGEMENT
Overview
In relation to each of the learning outcomes below, as a result of following this course, individuals will be expected to:

O1 What is BIM
Understand the principles of building information modelling and its application to the whole life inter-disciplinary design, construction and use of building and infrastructure developments

Acquiring internal resources
A1 Developing the business case, investment and return model
Understand the business case, investment and return model for BIM in order to be able to:
- Evaluate the benefits and risks of partnership and strategic sourcing
- Identify and resource the research and development of new products and services to meet market needs
- Identify opportunities to maintain and increase revenue
- Establish, implement and improve a business plan
- Allocate organisational budgets for projects
- Manage physical resources
- Manage business processes and improve performance

A2 Organisation and Project applications, and benefits of BIM
Understand the organisational and project applications and benefits of BIM in order to be able to:
- Identify and evaluate stakeholder, user, community and sustainability project requirements
- Confirm project energy efficiency and carbon minimisation requirements and strategies
- Establish arrangements for procurement and management of sustainable projects
- Prepare project briefs and development programmes
Induct and brief a project team

**Overview**

In relation to each of the learning outcomes below, as a result of following this course, individuals will be expected to:

**O1 What is BIM**
Understand the principles of building information modelling and its application to the whole life inter-disciplinary design, construction and use of building and infrastructure developments

**Tech 1 Identifying project requirements**
Understand how to gather, maintain and use BIM data in order to be able to:
Identify and evaluate stakeholder, user, community and sustainability project requirements

**Tech 2 Assessing contextual data affecting potential developments**
Understand how to gather, maintain and use BIM data in order to be able to:
Investigate and assess contextual factors affecting potential project developments
Identify, assess and take account of resource factors… etc
Investigate and assess regulatory and legal factors affecting potential developments

**Tech 3 Developing design solutions**
Understand how to gather, maintain and use BIM data in order to be able to:
Assess and develop sustainable project design options
Prepare and advise on project design recommendations
Assess, plan, estimate and control proposed development energy, whole life and capital costs
Plan and agree detailed project designs
Analyse and model environmentally sustainable project design solutions
Analyse, advise on and support sustainable solutions for historic and heritage assets
Manage health and safety in design
Investigate, develop and integrate detailed design solutions
Prepare applications and appeals to secure statutory consent
BAF aims to foster integrated collaborative working on projects over the lifecycle of the asset through academic involvement and the enhancement of BIM

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