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Architectural Technology

The Technology of Architecture

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Abstract: Architectural Technology is a relatively new discipline and relates to the anatomy and physiology of buildings and of their production and performance. The practice of Architectural Technology is underpinned by the application of science, engineering and technology and is closely aligned to industry. Architecture Technology is also set within an industry that is under capitalised, resource intensive, risk averse and litigious. Industry is now recognising the value of the discipline of Architectural Technology as critical in the digital age given its focus on empirically based design. Digitalisation of design and construction through Building Information Modelling, relates to production, performance, environmental sustainability, economic efficiency and effectiveness. BIM enables simulation, standardisation, systemisation, and optimisation in design and construction. One example of the relevancy of the discipline is how the skills of Architectural Technology align with those necessary for BIM and this hopefully create greater recognition of the discipline in the future. To improve the recognition of the discipline beyond the UK, this paper presents the educational and professional standards for Architectural Technology. The argument is made that concurrent industry interests in Building Information Modelling and in the profession, is an opportunity for both the expansion of the discipline and greater BIM adoption.

Keywords: Architectural technology, architecture, technologist, BIM.

1. Introduction

The profession of Architectural Technologist has moved away from the earlier draftsperson and technicians' role (Cheetham & Lewis, 2001). Architectural technology has been defined as the technology of architecture and encompasses knowledge and understanding which underpins the design of buildings and structures, as both a product and a process (CIAT, 2015). The profession is considered as a specialisation, with technologists contributing to construction teams as specialist designers who have unique strengths in building performance, production and process.

Architectural Technology operates within an industry that is described as under-capitalised, resource intensive, risk averse and litigious (Caplehorn, 2017). Building information modelling (BIM) is often acknowledged as a tool to navigate this challenging environment and deliver Lean construction (Dave et al, 2013). BIM is now recognised as key in the optimisation in the design, construction and resulting performance of buildings (Arayici et al., 2011; Hamza & Horne, 2006). The prominence of BIM aligns closely with the specialisms of Architectural Technologists, which lie in design and project management processes linked to the building life cycle through the integration of technology (Emmitt, 2009). BIM adoption is one example of the increasing relevance of Architectural Technologist as a growing profession and provides an opportunity for technology orientated professionals to take a key role within the industry (Morton & Thompson, 2011).

Architectural Technology is recognised as an academic subject in several countries and there are undergraduate and postgraduate programmes internationally in Denmark, USA, Canada (Armstrong et al, 2013; Barrett, 2011). In the UK, for example, there are 34 architectural technology degree programmes accredited by the Chartered Institute of Architectural Technologists (CIAT, 2015), most of which are aligned with other built environment provision, such as architecture, quantity surveying, building surveying and construction management. This paper will focus upon the formal and professional recognition of the discipline. For clarity, the UK is focussed upon in this paper because it has a single national professional body, and one which is increasingly also international in scope. A key purpose of this paper is to raise awareness of the value of Architectural Technology in order to support wider recognition internationally. To achieve this goal, there are three sections to this paper: the first familiarises the reader with the focus and scope of Architectural Technology as a discipline in the UK; the second details the educational context of Architectural Technology as a distinct career pathway; the third highlights BIM as a driver to greater professional recognition.

2. Defining Architectural Technology and the CIAT Example

Architectural Technology, as a design function relates to the anatomy and physiology of buildings and their production, performance and processes and is based upon the knowledge and application of science, engineering and technology. This is further linked to robustness and the life span characteristics of building systems, materials and components to achieve long term durability. It is also fundamental to the retrofit design of existing buildings and the methods of assessment needed to evaluate structures through the use of building diagnostics and pathology. Recent research on barriers to adaptive reuse existing buildings, highlights the need for a greater focus upon new knowledge and interest in technical performance standards of building regulation (Armstrong, 2016). A lack of discussion and empirical data of existing building technology present significant barriers to sustainable reuse of existing building stock (Hu, 2017). Previous regulatory shifts from prescriptive standards to performance standards requires technological, social, legal and economic understanding applied in a design methodology (Visscher et al, 2016). Looking to the future, there are now calls for building regulation codes and enforcement systems to shift again: from performance-based standards to risk-informed performance-based building regulation mechanisms (Meacham & van Straalen, 2017). A deep understanding of how design sits within technological, social and economic contexts is key to navigating legal minimum requirements.

As a discipline, Architectural Technology is able to crucially influence design in relation to construction processes throughout a building's lifecycle. This ensures that buildings remain economical, efficient and effective: desirable outcomes which are fundamental to new buildings and also the retrofit of design to existing buildings. Environmental concerns calling for carbon emission reduction (UNEP, 2009) underpin a renewed interest in the repurposing of existing obsolete buildings (Wilkinson, 2014). These concerns have generated the need to develop new approaches to evaluate existing structures through knowledge of building diagnostics and pathology to ensure that design solutions are compatible with the existing structure. Architectural Technology is exceptionally well placed to enable better project and design management process of the building life cycle through the integration of technology and the use of ICT, including modelling and enabling furthering collaborative practice to aid production, performance, efficiency and effectiveness.

Established in 1965, the Chartered Institute of Architectural Technologists (CIAT) is the professional Institute representing and supporting over 10,000 professionals working and studying in the field of Architectural Technology in the UK and overseas (Allwinkle 2008). Although CIAT began in the UK, CIAT has seven centres internationally and is actively developing international partnerships with universities and aligned professional bodies (CIAT, n.d.). CIAT is a Principal member of the AEEBC, (Association d'Experts Européennes du Bâtiment et de la Construction) and has Memorandum of Agreements with: Association of Architectural Technologists, (AATO) in Ontario, Canada; and Danish Association of Building Experts, Managers and Surveyors, known as Konstruktørforeningen (KF). However, one barrier to this is a lack of a wider recognition of Architectural Technology as a distinct profession, for example in countries such as UAE, Australia and New Zealand. Historically, UK has been a driver to the professionalisation and formalisation of distinct roles within the built environment, such as the Quantity Surveyor and Building Surveyor (CIQS, n.d.; AIBS, 2016).

3. Career pathway of Architectural Technologists

Historically architectural technology was a subject within other built environment courses e.g.: architecture and surveying. However, over the last 3 decades, Architectural Technology has emerged as a distinct academic course (or programme) which stands as a discrete and increasing well-respected career pathway. In the UK, there are currently 34 higher education institutions offering CIAT accredited Architectural Technology courses, as an undergraduate degree or masters program. In addition to CIAT accreditation requirements, these courses are governed by an established national system of quality standards that have been specifically developed for each course and provide national consistency and a recognised standard of education. Subject benchmark statements form part of the UK Quality Code for Higher Education (QAA, 2014b) which sets out the expectations that all providers of UK higher education are required to meet. The Quality Code (QAA, 2014b) aligns with the *Standards and Guidelines for Quality Assurance in the European Higher Education Area* (Thune, 2005). Subject benchmark statements (QAA, 2014b) describe the nature of study and the academic standards expected of graduates in specific subject areas, and in respect of particular qualifications. They are reviewed five years after first publication, and every seven years subsequently and is undertaken by an advisory group, representing the sector of architectural technology including chartered architectural technologists, academia, the profession and industry (QAA, 2014a). The Architectural Technology benchmark statement (QAA, 2014a) is a useful document to understand the distinctiveness and value of the profession.

3.1. Accredited Qualifications: Subject benchmark statements

Subject benchmark statements provide a picture of what graduates in a particular subject. The Subject Benchmark Statement for Architectural Technology (QAA, 2014a), sets out for example, what a graduate of BSc. (hons) Architectural Technology, might reasonably be expected to know, do and understand at the end of their programme of study and are used as reference points in the design, delivery and review of academic programmes. This general guidance for articulating learning outcomes associated with educational programmes is not intended to represent a prescriptive curriculum, but instead allow for flexibility and innovation within a framework agreed by the subject community. An advantage of a nonprescriptive benchmark statements is they are flexible enough to be helpful for international education providers who are seeking formalisation of technology programs as a distinct career pathway.

The ever-increasing professional diversity within Architectural Technology is also recognised in the benchmark statement (QAA, 2014a). Alongside this, the statement also highlights the demand for the subject at honours and master's degree level. The professional competencies of the Chartered Institute of Architectural Technologists have been used to inform and contribute to the content and body of knowledge that underpins this statement. It is predicted that an architectural technology career pathway and job functions will be diverse and evolve within an industry that is likely to go through major changes in the next decade (Morton & Thompson, 2011). The demands on practicing and the nature of procurements systems adopted by the construction industry invites projects to work actively with specialisms from their onset (Muir and Rance, 1995). In recognition of the professional diversity and employability of those working within architectural technology, the benchmark statements encourage adaptability, agility, diversity and specialisms in a fast-changing industry and work place with an attempt to future-proof knowledge and the development of new competencies and contexts. The design and construction functions have therefore become more complex and architectural technology is now a key subject in both functions with a primary focus on designing for building performance and construction production through and by the integration of technology.

The ever-increasing impact and influence of architectural technology on building design, the science and engineering of buildings, building and the design and construction processes, within the subject of architectural technology, has seen rapid growth and change. These changes are now impacting on the broadening and deepening of the subject knowledge of architectural technology and the need for specialisation and diversification beyond honours degree level. As a result of this evidence there is now a master's degree level criteria included within this subject benchmark statement.

3.2 Principles of Architectural Technology in Education

Realisation of architecture and its technology needs to be driven by a pragmatic decision-making process and a thorough understanding of the socio-technical context in which architecture sits, such as translating performance-based building regulations or codes into architecture. Performance of design requires socio-technological understanding as an increasingly central component of architecture (Imrie & Street, 2011). This demand requires designers to consider the broad range of end-user needs and to form creative solutions to meet the diversity of how end users with disabilities, older people or families with small children perceive, experience and use all aspects of the built environment. Considering core educational principles of the discipline, it is useful to make a distinction between the discipline and the academic representation. To help, there are 6 defining principles in the benchmark statement to consider (QAA, 2014a). These are comprehensive ranging from the need to have and international perspective (2.2) to requirement to develop collaborative relationships within the design team (2.5). Principle 2.1 provides an overarching definition of architectural technology as ‘a subject that is integral to the design of buildings and structures. It is rooted in science and engineering knowledge applied to the design of buildings to achieve optimum functionality; efficient and effective construction; and robust, durable and sustainable design solutions that perform over time’ (QAA, 2014a). Taken together, these defining principles adopt a holistic socio-technical perspective on the built and natural environment, and on the contribution architectural technology as an academic subject makes to the social, economic, legal, cultural, environmental, technological, business and political frameworks.

At an academic subject level, BIM is one mechanism useful to organise and generate architectural technology information. BIM is a tool which allows practitioners to efficiently and quickly manage building information (performance, process and product) to address the multitude of frameworks mentioned above. This view of BIM is expressed by Vanlande *et al* (2008:71), when they say, 'A BIM system is a tool that enables users to integrate and reuse building information and domain knowledge throughout the lifecycle of a building'. It is not without coincidence that recent research has also framed BIM within a socio-technical framework (Sackey *et al,* 2014). The academic subject of architectural technology and BIM are intertwined as BIM manages technical information pertinent of the lifecycle of a building. However, the link between BIM and the discipline of Architectural Technology is more subtle. The above defining principles of architectural technology as a subject can be argued to be the ideal outcomes of a successful construction project. The distinction of Architectural Technology, is in its focus on the skills and knowledge needed to deliver these outcomes (QAA, 2014a).

The subject benchmark statements are a revision of the QAA subject benchmark statement, published in 2007, which has now undergone a further review and been updated in response to a rapidly changing industry, society, environment, national and international economic dimension. The architectural technology subject benchmark statement reflects the changes in the context of the industry within which the subject sits, including the need to produce graduates that are employable yet adaptable, agile and flexible to respond to challenges and future changes. One criticism of this emphasis on employability, is that it is a generic and well-trodden narrative present in graduate employability policies in universities across the world. However, it could also be argued that the defining principles are abreast of wider university initiatives around graduate employability and industry demands.

The subject of architectural technology does not sit in isolation but is part of a larger academic domain comprising the built and natural environments, so this statement may be cross-referenced with other related subject benchmark statements (Allwinkle, 2008). All programmes are encouraged to draw upon knowledge concepts and paradigms from a wide range of sources. Professionals and students exist within a rapidly changing industry, where they play significant professional roles in leading, designing and managing projects and integrated teams, to deliver and achieve a sustainable built environment. This includes applying architectural technology as the link between design and construction to achieve the optimisation of production and long-term performance, with the use of ICT and modelling technologies, for example BIM adoption, for managing, assessing and evaluating projects.

One beneficial distinction of Architectural Technology is that it focus on technological design straddles STEM and creative subjects. In the UK, Architectural Technology is categorised as generating 'creative graduates', alongside other architecture related courses such as landscape and interior architecture (Faggian, *et al.,* 2013). Comunian *et al.* (2014) highlight the often overlooked contribution that these groups of graduates make to the creative economy. They also outline the findings of UK based research, and which confirms a commonly held belief that Arts and Humanities (ie creative) courses often have career progression within lower paid jobs than those within science, technology, engineering, and mathematics (Comunian *et al.,* 2014:426). One attractive distinction for architectural technology graduates in the UK, and elsewhere is that their creative knowledge is applied through a STEM specialism. Further research is needed to examine how Architectural Technology graduate salaries compare with other creative courses in Arts and Humanities.

The STEM aspect of Architectural Technology has other appeals for potential higher education students. In a paper on marketplace in higher education, Wilkins *et al.* (2013) describe an 'increasing shift in the cost of higher education from the state to the student' highlighting that arguments about value for money of respective university courses are often rehearsed (p.125). They claim that this shift is not limited to England, where fees were first introduced in 1998, and is a global shift, occurring also in Australia, Canada, Italy, Japan, the Netherlands, New Zealand, Spain and the USA (Wilkins *et al.,* 2013). The benefits of this STEM focus need to be investigated further by research and in terms of attracting potential students who are dissuaded by the cost of long courses in built environment and given resulting salaries. In this context, it is relevant to note Architectural Technologist can become chartered through a degree plus an industry experience assessment. Masters level courses in Architectural Technology are focussed on developing a deeper specialisation and depth of knowledge rather than a linear route to chartered professional status in Architectural Technology.

Beyond the QAA Subject Benchmark Statement for Architectural Technology, the Chartered Institute of Architectural Technologists publish Educational Standards for graduates in progressing to Chartered Architectural Technology recognition. The standards are concerned with the application of knowledge and the developing best practice in industry. The statement thresholds and standards are similar to those demanded by other aligned professionals. However, it is their emphasis and synthesis of science, design and management of the technology of architecture which is distinct.

3.3. Career Profession of Architectural Technologists

Common to other built environment professional memberships and qualifications, currently there are two routes to becoming a Chartered Architectural Technologist (CIAT, 2017). One is through professional recognition of built environment experience and application of knowledge in industry. This requires professionals to submit of a Professional and Occupational Performance (POP) Record and to successfully pass a professional practice interview with CIAT (CIAT, 2017a). This POP route is arguably more suitable for professionals who are seeking chartership through the range of industry experience built up over time. Graduates of CIAT accredited courses, however, often choose the second route: via the MCIAT Professional Assessment, which involves graduates successfully passing a professional practice interview after producing an in depth, critical report. The report must summarise: 'their knowledge, understanding and application of the construction process with regard to planning, design, construction and use, as well as relating it to their professional experience' (CIAT, 2017b). This latter route has been streamlined for graduates to reflect the subject benchmark statements (QAA, 2014a) and uses language familiar to those who have studied on a CIAT accredited course. These two routes are in recognition of the equal value placed on formal academic achievements and industry experience, as well as recognising the range of skills and variety of work undertaken by Architectural Technologists.

The interview process is designed to reflect the broad nature and range of professional practice within the profession and discussions are based around the information provided in the candidate's POP Record or Professional Assessment Report. This assesses a candidate's: knowledge of the construction process; relevant experience in their field of Architectural Technology; overall experience in the industry; and also their professionalism (connected to Code of Conduct). The interview is assessed by a panel of experienced Chartered Architectural Technologists, who have undergone training in the moderation and assessment of candidates. The interview is a peer to peer assessment and designed to enable the Institute's assessors to make a judgement regarding an applicant's professionalism and suitability to represent the Institute as a Chartered Architectural Technologist. Candidates are also encouraged to seek mentorship and professional development through the CIAT network to support their application and to demonstrate their professionalism and understanding of the technology of architecture. The professional interview is assessed using the Institute's Code of Conduct.

Nadim & Goulding (2009) claim that there is a gap between the knowledge and skills of graduates of built environment courses and the needs of industry, and note there is no firm agreement between academia and built environment industry leaders in how to bridge the barriers to greater collaboration (p.148). CIAT is professional organisation comprised of members in industry (QAA, 2014a). It could be argued that the partnership between industry and higher education, intrinsic to current Benchmark Statements and Standards, and which define the profession, are produced through collaboration from the outset. Assessment involved in progression to Chartered status through and the peer-to-peer assessment of the professional interview is also an example of this collaboration to ensure that the skills of a Chartered Architectural Technologist meet the needs of industry.

4. Architectural Technology and Changes in Industry: BIM

BIM adoption involves moving away from traditional architectural information production and designing towards a different was of designing and communicating. Traditional drafting by hand, or through using 2D computer aided design (CAD), remains a drafting tool with its purpose to represent designs on paper. In their influential guide to BIM, Eastman *et al* (2011), claim that BIM involves a revolutionary shift, away from abstracted drafting to the realities of building: 'modelling is akin to actually building the building' (Eastman *et al,* 2011:388). BIM technologies are more than just a new generation in CAD. Their use requires process-based understanding of construction as well as a sound familiarity with architectural technology. The skills set described by Eastman *et al,* 2011*)* as necessary for BIM adoption is in symmetry with Architectural Technologists, as set out in the subject benchmark statements (QAA, 2014a).

This is a major opportunity for Architectural Technologists and for Architectural Technology being critical in the digital age and empirically based design through Building Information Modelling (BIM) relating to production, performance, environmental sustainability, economic efficiency and effectiveness (Kouider & Paterson, 2014). Ghaffarianhoseini *et al* (2017) highlight that although rhetoric is encouraging, BIM has yet to be adopted widely in the global construction industry. In the fifth NBS National BIM Report (NBS, 2012), a national survey in the UK involving over one thousand respondents, Architectural Technologists are the second largest professional group in the UK to adopt BIM (21%). Registered architects are the largest professional group who report to have adopted BIM (37%). At the time of the NBS BIM survey (2011), UK had over 55,000 registered architects (RIBAJ, 2016). Whereas current membership of professionals who are allied to the professional body CIAT was around 10,000 (CIAT, *n.d.*). As the number of UK registered architects are greater in number than CIAT members, the uptake of BIM overall by Technologists can be argued to be proportionally much larger.

BIM is a significant design tool for architecture but needs to expand from aesthetic presentation towards an increasing emphasis on simulation, standardisation, systemisation, simulation and optimisation (Hamza & Horne, 2006). BIM is therefore critical to optimise and improve industry performance as a process and buildings as products Architectural Technology is now an essential design function and through the application of BIM will ensure that design solutions result in buildings that can be constructed economically and perform efficiently and effectively within the context of user needs, environmental, regulatory and budgetary requirements. BIM and its design influence on the construction process cannot be understated as this will ensure that buildings are economically efficient and effective and design and construction innovation in terms of scalability, replication, robustness and reliability will form a major part of this design function. BIM and software applications will need to be harnessed and Integrated into education and professional and industry standards at all levels to ensure that the construction industry is modernised and is able to achieve various

EC targets. BIM, Architectural Technology and Architectural Technologists are inextricably linked and offer the industry and society the platform and professional competence to ensure that BIM challenges and changes are achieved (Hamza & Horne, 2006).

As we look to the future, there will be unprecedented opportunities in the sphere of design practice for Architectural Technologists. Functions, procurement, and practices are continually changing and are becoming more diverse. The adoption of BIM will drive further major changes encouraging a growth in specialisation, specialisms and an increasing need for specialists. We argue that Architectural Technology is ideally placed to take a central and integral role in the adoption of BIM, through these changes. As a profession, Architectural Technology will benefit from the diversity, adaptability, agility, and specialisation of its members. Increasing complexity in projects and their procurement routes will necessitate less focus on professional title and more focus on function or roles within a design team.

A key driver for these changes in the UK is the government's commitment to Construction 2025 (Cable et al., 2013). This strategic policy has some ambitious aims, including: lowering construction costs and the whole life cost of built assets by 33%; lowering carbon emissions by 50%; and delivering projects 50% faster with a 50% improvement in construction exports. These targets present major challenges and require major changes in practice. The discipline specialism and particular practices of an Architectural Technologist have long been highlighted as beneficial in the drive to link lean design with lean construction (Brookfield et al, 2004). In the recently published Architectural Technology Benchmark Statement, greater emphasis is placed on design principles to achieve effective, robust and sustainable design solutions (QAA, 2014a). Architectural Technology can have a key role together with BIM, providing the framework and the applications to achieve commitments set out in *Construction 2025.* Modernising the construction industry through BIM adoption requires creation of new communities of practice and collaboration (Caplehorn, 2017). In addition, enhanced collaborative working is one of the benefits of BIM adoption (Sacks *et al,* 2010). As Architectural Technologists often operate as a design specialist within a team, they are well adapted to the demands of collaborative working in communities of practice (Thompson, 2012).

5.0 Architectural Technology: Conclusion

The increasing recognition of graduates skilled in the science of architecture, coinciding with an increasing call for greater BIM uptake, is an important concurrence. This paper has argued that Architectural Technologists are best placed to assist in the adoption and increased use of BIM in industry to drive lean and more sustainable modes of design and practice. Further research is needed to ascertain if this view is occurring in reality in industry, and if so, can the Benchmark Statements and Standards be further developed to convert the rhetoric of BIM into widespread adoption in industry.

Whatever the future may hold for Architectural Technology is there will always be a pressure to meet changing circumstances which create demands on the industry, focused not only on ever more technically complex, high profile structures but also on the provision of sound, reliable building to meet the requirements of those seeking more traditional solutions. The professional discipline and performance of architectural technologists in successfully meeting these demands will surely remain one of the prime objectives and will ensure their increasing recognition and value as it meets the challenges and grows in stature, as it most certainly will.

The development of Architectural Technology has come a very long way, certainly, much further than any of the founders imagined when it entered the world of professional institutions in 1965 (Allwinkle, 2008). Endacott (2005) chronicles the progress made since then, but what cannot readily be recorded are the efforts made to reconcile the desire and commitment for recognition with the challenges inherent in establishing a new discipline. It is a tribute to all concerned that against a background of constantly changing technology and legislation, the needs of the profession have been met through soundly implemented education and training policies in the UK. The professional status, now achieved, is underlined by the respect and value accorded to Architectural Technology. The professional body, CIAT is included in the wider councils of the UK construction industry. This inclusion underlines the industry recognition afforded to the discipline, professional body and its members.

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