Toward a Data-Driven Architect - A critical investigation into Data-Driven Design and the future of the Architect in the UK.

Allister Lewis
Ayre Chamberlain Gaunt Architects, Belvedere House, Hampshire, RG21 4HG, UK
email: Allister.lewis@acgarchitects.co.uk

Abstract

The introduction of new technologies within the construction industry and requirements to reduce costs, programme duration and carbon emissions has revealed that architects need to understand the opportunities and threats to their profession. This paper captures the emerging concept of data-driven design and how it applies to the role of Architects, using interviews with ten experts in the field of data-driven design. Using a Grounded Theory approach, this investigation critically explores how data-driven design is conceptualised, what skills Architects need in relation to data-driven design, and what impact this may have on the future of the profession.

The outcomes of this research demonstrate that in order to meet future construction industry requirements, Data-driven design requires a reconceptualisation of the Architect profession. The research identifies four alternative futures for Architects; stasis, hybridisation, the loss of Architects to Building Information Management roles, or the emergence of a new profession. It reveals that Data-driven design is changing the way that Architects work, with new skills required to manage and understand data within architectural practice. A model is presented that illustrates how Architects will need to change and adapt fast in a technologically driven construction industry or face marginalisation as a new Data-driven design role emerges.

Keywords: Architect, Building Information Modelling, Data-Driven Design, Computation, Construction

1. Research Problem and Rationale

The construction industry in the United Kingdom (UK) has changed since 2011 due to the introduction of the Government Construction Strategy (Cabinet Office, 2011). The strategy introduced governmental requirements for digital technology to be utilised by the construction industry to reduce costs, increase efficiency and generate better outcomes for government clients. Within this context Architects were required to respond and update their skills to include processes such as Building Information Modelling (BIM). An analysis of further future requirements, such as the Construction 2025 Report (HM Government, 2013) outlines that Architects may be expected to update their skills further to support a reduction in carbon emissions, costs, and timescales. With the growth in global population predicted, pressure on resources and the continuance of climate change, there is a need for Architects to adopt new and innovative practices in the future (Airaksinen, 2016). It has been identified that a minority of Architects have responded to this challenge by developing specialist areas of expertise in software and digital processes – data-driven design. The use of data within their offices and projects, and the use of advanced BIM authoring software, could provide some of the solutions to government requirements and wider construction industry needs. Therefore, an understanding of what data-driven design is within this context and the benefits that it can contribute to the construction industry requires investigation.

2. Aims of this Research

The aim of this research was to understand how some Architects have responded to new digitisation and construction requirements. Furthermore, an understanding of how new technology may affect the role of Architects in the future and how this may support the meeting of the construction industry requirements was investigated. The research aimed to inform future practice and the role that Architects have within this. Three research questions were asked and analysed, see Table 1.

Table 1 Research questions

1.	How do data-driven design specialists conceptualise data-driven design?
2.	What competencies might be required of Architects in the future?
3.	From the perspective of data-driven design specialists, what impact will data-driven design have on the role of Architects?

The future for professions

Susskind and Susskind (2015) highlighted the difficulty in defining what a profession was universally. They discussed that one problem with professions is that they are a small group that provide a service to another relatively small, privileged group. They argued that a greater distribution of expertise, at a reduced cost, should be adopted for the benefit of greater number of people. However, the challenges for professionals is that typically they underperform and Susskind and Susskind (2015) urged for a radical re-evaluation of the ways that they work to resolve this. One of the solutions is the use of technology to support change; *"systems of today are increasingly out-performing human experts, not by copying high-performing people but by exploiting the distinctive capabilities of new technologies, such as massive data-storage capacity and brute-force processing"* (Susskind and Susskind, 2015, p. 45). It appears that Architects would benefit from an awareness of the implied threat to their future position as professionals performing a specific service. How the role of an Architect is conceptualised in the UK, is an area that appears ready to be re-examined.

The Existing Role of Architects

In 2010 the RIBA published a report that examined the future for Architects (Jamieson, 2010). This report identified that changes in the construction industry will alter the context within which Architect's work. The report asked *"who will design our built environment in 2025 and what are the roles required and how well Architectural practice change?"* (Jamieson, 2010, p. 6). As this was prior to the Government Construction Strategy (Cabinet Office, 2011) there was no mention of BIM Level 2 and the Construction 2025 aims or BIM Level 3. However, it identified the title of Architect as being restrictive and that small practices were resistant to integrated technologies, which support BIM methodologies on cost grounds (Jamieson, 2010). The report also raised concerns that senior members of small practices were relying on young people to keep up-to-date and there was a risk of senior staff being deskilled over time. One concerning aspect in the report was; *"Architectural profession unfortunately does not view itself as part of the wider construction industry"*, however they confirmed that this should be changed (Jamieson, 2010, p. 13). It was identified that Architects were reducing in number over time and therefore there was a threat to the influence that Architects have. The report lacks depth regarding future technologies and the requirements for increased sustainability and life-cycle data management, which is a deficiency. One area of concern is that the report promoted; "*practices should concentrate on capital cost savings and not whole life costing, in order to be more persuasive to the client, in this way they are in a better position to raise their fee"* (Jamieson, 2010, p.

34). When set against the priorities that have since followed, this is contrary to the UK Government's BIM Level 2 requirements, particularly Government Soft Landings (BSI, 2015) and the best use of assets and data over the lifecycle and contradicts Susskind and Susskind (2015). Since 2010 there have been several developments that mean this document is now out of date and there is an opportunity to examine the future role of Architects further.

The Future Role of Architects

The decline of the Architect's influence within the construction industry was described by Derbyshire (2014a), who argued that the profession has declined since its peak in the 1960s. Derbyshire (2014) developed this argument and posited a future where innovation and the use of BIM can support a profession that can thrive. Derbyshire argued that part of the solution as; *"BIM and CADCAM (Computer Aided Design/Computer Aided Manufacturing) create the possibility of previously unheard of consumer information, choice and mass customisation of the housing product as never before"* (Derbyshire, 2014). Deutsch (2017a) suggested a profession which is struggling to collaborate and work effectively with other consultants. In addition, he identified communication and collaboration changes that affect speed, cost and quality as important. Deutsch (2017a) identified that using fewer resources, adding innovation and value, and reducing waste was now a standard expectation for Architects from clients but this was difficult to achieve with current work practices.

Deutsch discussed that Architects should reset their role as leaders and "*account for data and information derived from the digital models"* (Deutsch, 2017b, p. 2). Deutsch (2017b) examined the use of data by Architects and how data can support better design decisions and critical thinking could be supported with the use of data rather than stymying creativity. He also discussed how Architects perceive the use of data and how this may be considered a distraction from the core competency of 'design'. Deutsch (2017b) argued that the use of data should enhance craft and increase the speed of decisions and therefore support good design. Deutsch (2017a, p. 94) stated that; *"Being aware of data and understanding of the role of it can and should play in one's practice is very, very important."* Furthermore, Deutsch (2017a) argued that Architects will learn to use data the way that Architects needed to learn how to use pen and trace. Deutsch (2017a) foresees a future where data forms the foundations with which Architects make design decisions. He postulated that design decisions would be made quicker and increase productivity as a result. Deutsch does not confirm where these points originated from or the veracity of them, although many of his observations were based around interviews with practitioners. However, a rigourous research methodology was not communicated and therefore cannot be generalised across the wider industry.

Garber proposed that *"today's digital tools expand, rather than constrain, the authorial and ambit of Architectural design. Architects will have to learn all the rules of the new game to prove him right"* (Garber, 2014, p. 13). Within this context, Garber (2014) discussed that the qualitative design aspects of BIM had been underexplored as these were areas which were not typically linked to cost or more pragmatic requirements. Bernstein (2017) concurs and argued that the value proposition of the Architects contribution to the making of buildings and how digitisation could contribute to this needs re-evaluation. It appears that although technology is being introduced, the issues of retaining design control is a central issue to Architects. If data-driven design can contribute to a greater level of design and creativity this would reveal a valuable contribution to the profession. It would also help Architects to move forward and adopt the technology sooner.

Gauchat (2009) identified that BIM could lead to Architects having either increased importance or increased marginalisation. The requirement to innovate and develop new approaches may test the abilities of Architects and Gauchat (2009) proposed that BIM will be a key aspect of the construction industry in the future. Gauchat (2009) anticipated that companies which were technologically advanced will provide a higher level of service for clients. Gauchat (2009) proposed that education should focus on judgement, teamwork skills, intimate knowledge of design and building delivery. By identifying these skills Gauchat (2009) thought that technology was not the only driver for improvement but better collaborative behaviour of design teams. Ottchen (2009) concurred with this and promoted a *"re-conceptualised from that of romantic genius to technological guru to that of multidisciplinary strategist"* (Ottchen, 2009, p. 25). This investigation illustrated that technological change means that the tools used need to be better understood. The Architect as a team collaborator should be investigated

further to understand what this looks like as there are multiple views on how this could be implemented; as a technological approach or as a collaborative team approach.

Data and the Construction Industry

Schwab (2016) proposed that; *"technology and digitization will revolutionize everything"* (Schwab, 2016, p. 14). He explained that digitisation is altering the way that individuals and institutions collaborate and discussed the impact this will have on productivity and the lack of progress thus far (Schwab, 2016). Schwab (2016) identified four impacts of data use on business, one of which was *"products are being enhanced by data, which improves asset productivity"* (Schwab, 2016, p. 54). Schwab (2016) uses the year of 2025 as a benchmark to determine if changes will have occurred in many areas, which would align with the Construction 2025 report timescales (HM Government, 2013). Schwab (2016) highlighted that there was an expectation that the construction industry will change between 2011 to 2025 and indicated that the construction industry workforce will need to be upskilled to be digitally enabled.

Susskind and Susskind (2015) proposed that these changes were early examples of technology bringing about change to a profession, which presented a challenge as well as an opportunity. They proposed that new disciplines and skills were required to manage the use of this data. Susskind and Susskind (2015, p. 303) concluded that in the future *"increasingly capable machines will transform the work of professionals, giving rise to new ways of sharing practical expertise in society"*. They confirm that industrialisation and digitisation will change the landscape and lead professions to be *"replaced by less expert people and high-performing systems"* (Susskind and Susskind, 2015, p. 303). They conclude with a proposal to democratise the access to information and make it widely available for the greater good of society.

Allen (2017) proposed a radical future for architecture that was supported by generative design, software algorithms and robotic construction within the next ten years. Allen (2017) argued that *"Building Information Optimisation"* will be the way forward with computers taking on more of the day-to-day work. Furthermore, he argued that many companies have used traditional BIM as an extension of CAD, and this is limiting progress. Allen (2017) proposed that data may inform design and add information to support problem-solving for Architects. Similarly, Garber (2014) observed new professional models within practice, including; strategic, implementation, consulting and software development units within an organisation, demonstrated by companies such as CASE[1]. Garber (2014) insisted that Architects must understand and utilise the opportunities that arose with change to have a definite creative direction. Garber's work is a useful demonstration of the issues facing the industry with useful examples. However, his approach covers larger practices mainly and niche expert digital design practices. Evidence of the wider effects of how technologies impact on the construction industry are required to be demonstrated. It appears that there is space to develop this in a more quantifiable way and this will be developed within this research to explore how professionals conceptualise data-driven design. Therefore, it is clear that they believed that the introduction of technology will change the role of professionals to a greater extent than has happened in the past and Architects need to consider how this affects them in the future. Within the context of this research project, an assessment of how to achieve this appears pertinent to explore.

Skills of an Architect

An analysis of the skills required by an Architect that relate to data-driven design has revealed that this is a very new area. The RIBA Skills Report (2014) suggested that employers were looking for 'BIM' as a skill, which demonstrated a lack of understanding of BIM as a process, and failed to fully explain what this involved. This report explored a number of skills which were required by architectural practices, including software skills. However, it did not go into detail or mention what these include.

A review of the RIBA Code of Professional Conduct (2005) proposed that Architects should; *"apply high standards of skill, knowledge and care in all their work"* (RIBA, 2005, p. 4). Skills were only mentioned once within this document, and can be compared to a more recent RIBA Student

[1] Now part of the WeWork organisation

Destinations Survey 2017 (MacKinnon, 2017), which illustrated that Information Technology (IT) skills is within the top ten skills required. Again, further definition of what these actually entail was not defined. Young (2015) also mentioned 'BIM' as a skill required of new Architects but failed to define what this actually includes. Therefore, it appears there is room for further definition of what skills are required within the realm of digital design and BIM for Architects.

3. Methods

3.1. Research Type

Grounded Theory is an example of inductive reasoning, and was developed by Glaser and Strauss (Lingard, Albert and Levinson, 2008) to generate theories regarding social phenomena. A bottom up inductive approach supports the use of Grounded Theory as a method that constructs a theoretical analysis based on data, utilising analytical strategies and implicit guidelines for data collection (Charmaz, 2005). It is used to explain a process and uses iterative design to study data collected simultaneously (Lingard, Albert and Levinson, 2008). The data is constantly compared and theories emerge, which are refined over time as new data was introduced. Grounded Theory generates data first and then produces a theory inductively from this. The approach will be selected for the research as it responds to the findings and will ensure theories are developed as the research continues. The advantage of this is that the research will begin with no assumptions on what a data-driven Architect may look like and the enquiry will identify patterns in the data (Cottrell, 2014). Disadvantages to this approach may be the time required, how this is managed and the depth of investigation required. These will be considered as part of the approach and a deadline for data collection established.

3.2. Part 1 Interviews

Interviews with specialists working within the area of data-driven design will be interviewed to understand their approach to the conceptualisation of data-driven design, skills required and how this affects the role of Architects. Reason and Bradbury (2006) confirmed that the risks and benefits from participation should be communicated honestly. They go on to explain that informed consent provides autonomy and privacy. Reason and Bradbury (2006) suggested that a researcher should adopt a relational approach that showed concern for the well-being of the interviewee during the interview and also what happens afterwards. To support this, the researcher will be reflexive to the participants and evaluated responses, this will mean understanding the effect of the researcher at every stage of the research process. The interviews will be synchronous and mirror traditional interview techniques when conducted online. The advantage of this will be real-time responses from interviewees and a high level of involvement from them. Busher (2012) suggested that a disadvantage to synchronous interviews could be that participants fall behind due to a fast pace. To overcome this a limited number of open ended questions will be used (see Appendix 1), progressing at the participants own pace, and ensuring that participants are ready to move on to the next question. Ten interviews will be held until data saturation is reached, for example when participants begin to repeat the same answers to the questions. This means that once the information is being repeated the interviews will conclude.

3.3. Part 2 Thematic Analysis

Nowell et al. (2017) argued that thematic analysis is a qualitative analytical method with the ability to be utilised on a range of epistemological and research areas. It can be used for "*identifying, analyzing, organizing, describing, and reporting themes found within a data set"* (Nowell et al., 2017, p. 2). Thematic analysis provides a very flexible methodology that can be amended depending on the area

studied, which can lead to the analysis of deep and rich data. Nowell et al. (2017) argued that thematic analysis can summarise key features of large datasets, however disadvantages can include inconsistencies due to a lack of consistent methods. To overcome this, consistency will be supported by confirming the epistemological position early on, in this case the use of Grounded Theory.

The following process of thematic analysis will be adopted, as recommended by Nowell et al. (2017, p. 4). One-to-one interviews will be held with experts and a set number of questions will be asked of each participant. The questions will explore each participant's role and their understanding of data-driven design. In addition, a question regarding their understanding of the Architect's role within data-driven design will be explored and linked to the design or design process. The opinion of the interviewee will be asked on the future direction of data-driven design and how this influences the role of the Architect and why.

The skills of an Architect will be explored to understand what may be required in the future and this will be linked to their own experiences and how it has assisted them in getting to where they are. Finally, any additional information will be asked of the participants to ensure they had the opportunity to propose additional comments.

3.4. Part 3 Summary Questionnaire

In order to corroborate the data and coding outcomes a summary questionnaire will be issued to enable participants to understand the findings and comment on these. This corroboration of the information was recommended by Nowell et. al (2017). The questionnaire will outline the findings and contain the participant's own transcripts of their interviews for them to comment on the information to ensure they are an accurate representation of the conversation held. In addition to this a feedback form will be included to enable participants to provide commentary on the findings, supporting Nowell et. al's (2017) advice, and ensured that participants have an opportunity to respond to the findings.

4. Results and Analysis

4.1. Introduction

Ten interviews were held with expert participants in the field of data-driven design to uncover knowledge based on the three research questions. These questions will form the structure of this chapter confirming the themes and then returning to the literature to inform the analysis. The outcomes will be summarised in a model to illustrate the findings.

How do data-driven design specialists conceptualise data-driven design?

In order to understand the field of data-driven design, it was important to define what data-driven design was by professionals who were working in this field. This conceptualisation enabled further understanding of this field. Five key themes were identified from the participants and are demonstrated in Figure 1.

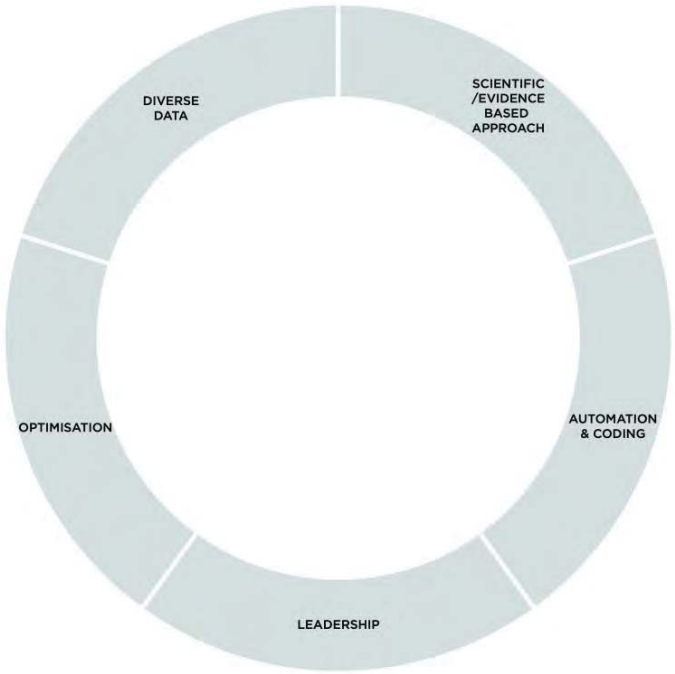

Figure 1: Conceptualisation of data-driven design

Data-Driven Design Conceptualisation Analysis

Question one asked how the participants conceptualised data-driven design. The literature review illustrated a lack of evidence and clarity of what a 'data-driven Architect' will be within the UK in the context of Construction 2025 (HM Government, 2013) report. Furthermore, the diverse nature of the roles of Architects and how they may work, in many different fields, disciplines and sizes of organisation, suggested this wide approach may result in a generalised view, which is not purposive. Deutsch (2017b) conceptualised that data-driven design was something that provided benefits for Architects. However, the detailed conceptualisation of what data-driven design was, appears to have been missed. The themes that have emerged from the research appear to demonstrate that an approach to data by Architects was important and definable. A scientific, evidenced-based approach was considered important to be able to understand data in an objective way, representing a gap in the literature to date. How data is approached, and the methods used to analyse it, were considered important, particularly moving away from a subjective, experiential approach to a more fact-based and scientific, objective approach.

The responses demonstrated that diverse data sources are now being used by participants, departing from traditional modes of analysis. Some of the participants mentioned beginning to use diverse digital data or 'big data' sources to inform their projects, such as social media data linked to a site that was being developed. Also, participants were also relying on their own organisation's historic data to inform projects. Many of the participants discussed the collection and standardisation of their information in a digital way to learn from past mistakes, increase efficiency and speed for future projects. This area could demand further attention to understand how this is recorded, encoded into an understandable or useful format, and shared within the practices they work. Optimisation appeared to be a concern for many of the participants, representing a view that the existing ways of working were inefficient and outdated. The approach to optimisation from the participants considered effectiveness and the ability to produce information faster as essential to meet current needs.

Jamieson (2010, p. 34) illustrated this within the RIBA report; "*practices should concentrate on capital cost savings and not whole life costing, in order to be more persuasive to the client, in this way they are in a better position to raise their fee"*. The statement in hindsight contradicts the concept of BIM as a life-cycle approach to a building. Many of the participants directly argued against such an

approach and expressed a desire that greater appreciation of the life-cycle should be considered to create more efficient and cost-effective assets. The work of Susskind and Susskind (2015) also discussed a need to understand the future challenges that the Internet and democratisation of data. By driving up fees this will actually reduce access to Architects when they are needed most to help solve societal pressures. It is suggested here that more efficient and automated processes could lead to Architects spending less time on projects and are producing work faster. However, in a profession where fees are relatively low (Jamieson, 2010) it is unlikely that this will be accepted unchallenged as it will go contrary to the ability for Architects to argue they add value. However, in light of future technological change, with greater automation, it should be considered very carefully.

The use of automation and coding to support the process of delivery, design and understanding of large datasets was discussed by many of the participants. The participants commonly suggested that Architects should either understand code, or be able to use coding, so that they can utilise this information for the benefit of a project. Furthermore, the use of automation to support their organisations to be leaders in the market was seen as important to enable a competitive advantage over similar practices. It appears that coding and visual scripting should be incorporated into the Architects future education and start to inform university courses and Continual Professional Development (CPD). Updating the ARB course requirements for certification to ensure properly trained individuals are ready for the future appears pertinent to consider. Schwab (2016) confirmed that *"technology and digitization will revolutionize everything"*. Many of the participants were aligning themselves to take advantage of this in the future.

Participant 7 communicated that Architects have either lost, do not have the power to influence, or are no longer interested in, being leaders within the construction industry. Gauchat (2009) concurred and identified that BIM could lead to Architects elevating their status or could lead to further marginalisation. Furthermore, Deutsch (2017b) concurred and proposed that Architects should re-establish their role as leaders within construction. However, there were different views on how this will be enacted. Will Architects change and morph into something new or the creation of a new discipline entirely? The latter appears to be more likely in view of the participants, due to the perceived entrenched traditional nature of Architects and their inability to change. A new professional role within the construction industry that manages and leads data integration, management and design would disrupt a traditional industry adverse to change.

What competencies might be required of Architects in the future?

An examination of the competencies and skills required was investigated with themes specific to skills and competencies analysed from the text and compiled (see Figure 2) to represent the competencies that data-driven Architects may require in the future.

Figure 2: Question 2 results diagram illustrating new skills required

Architect Competencies Analysis

The competencies required of Architects in the future will be diverse and varied. It appears that some of the competences exist currently and are broadly contained in the ARB criteria. For example, the ARB criteria stated; *"Collaboration in construction and provisions for team working"* (ARB, 2012, p. 14). However, there was no mention of how data or other sources will inform decision-making processes and this appears to be a deficiency. Furthermore, coding skills and research skills are not mentioned as core skills required, suggesting a gap in the criteria, and may reflect why research levels are at a low level within Architects in practice (Miller, 2017). It is recommended as a research finding that this is updated. The RIBA have changed their criteria in the past to reflect modern requirements; in 2015 the charter was updated to promote greater diversity and reduce inequality within the profession (Clark, 2015) and an update to the ARB and RIBA criteria to reflect emerging requirements is possible.

Ottchen (2009, p. 29) proposed that Architects should be; *"re-conceptualised from that of romantic genius to technological guru to that of multidisciplinary strategist"* aligning with the concept of a trusting, sharing collaborator and synthesiser of information and data. This involves the use of softer skills such as communication, negotiation and leadership skills. The Farmer Review (2016) discussed that collaboration was an issue within the construction industry generally, and that successful BIM was predicated on increasing collaboration. Farmer (2016) argued that *'open linked / big data'* use has been lacking and future skills required have not been maximised. Furthermore, he promoted that *'data silos'* should be dismantled for the wider societal benefit. The research has demonstrated that Architects would benefit from challenging existing culture and become lead collaborators integrating design team as well as constructors. The participants stated that Architects were not meeting this challenge currently due to ingrained cultural ways of working and this was limiting the adoption of data-driven strategies across the design team. With the use of more collaborative software, processes, contracts and a more integrated construction industry, these collaboration skills should be understood and enhanced in academia and in practice.

Deutsch (2017a) identified that research was an area that required greater investigation, leading to new specialisms and skills. Many of the participants were actively researching or understood the value of research to develop and enable innovation and new solutions. Research appears to be an area ready for development across the construction industry and the benefits of this could be wide-ranging. How this is shared and communicated will require further research.

The process of delivering a project was not mentioned by the ARB (2012) and many of the participants discussed how they were approaching existing processes and striving to increase the quality of these. Many of the processes discussed within the criteria are purely abstract, such as the 'Planning' process. The delivery of projects, coordination with other consultants, and the production of information is a process that is a critical area for understanding. New methodologies are emerging such as Lean in Construction (Constructing Excellence, 2015), representing one area that appears relevant to be taught. The discussions demonstrated that data conductor or integrator skills will be required for future projects. Furthermore, the concept of coding, data management and automation were not mentioned within the ARB criteria and, as the document was produced in 2011, there is an opportunity to update and contribute new learning outcomes for future students of architecture.

A finding of this research is that the skills required of an Architect appear to need updating to align with the data-driven approach to increase the efficiency and quality of architectural practice. This may result in a new scientific and creative designer integrating data to make new and innovative solutions. Garber (2014) insisted that Architects must understand and utilise the opportunities that arise to have a definite creative direction. Peters (2013) anticipated that computation will augment the intentions of the designer and allow problem-solving skills for complex projects to be increased. Evidence was presented by the participants who communicated that innovative complex problem solver skills will be needed.

From the perspective of data-driven design specialists, what impact will data-driven design have on the role of Architects?

How data-driven design affects the role of Architects and how this may change in the future allowed participants to discuss the current limitations of the role and how traditional practices did not

allow the profession to move forward. The four themes that emerged represent future roles that data-driven Architects may fulfil (see Figure 3).

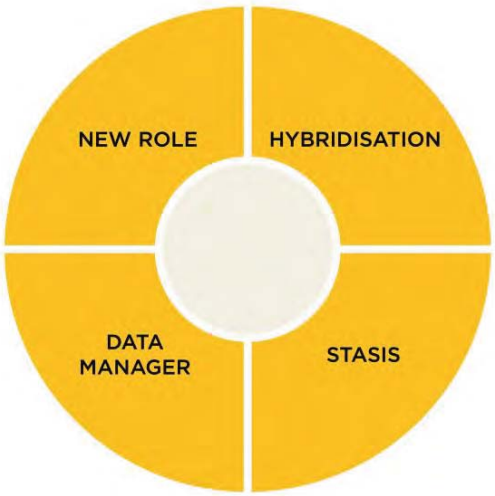

Figure 3: Question 3 results diagram illustrating future role types

Analysis on the Impact of Data-Driven Design on Architects

The impact that data-driven design will have on the role of Architects was discussed by the participants and this aligns with the literature review. Jamieson (2010) proposed that a broader definition of Architect with multiple career paths could be established, responding to the changing nature of the construction industry with different priorities emerging. Similarly, the Construction 2025 (HM Government, 2013) report demonstrated that the future targets are challenges which may require a new type of professional.

The hybridisation of the role to a scientific and artistic one leads to a re-conceptualisation of the role of Architect. If Architects move from a purely artistic and creative role, new specialisations or new approaches will result. A finding of this research is that currently university courses offer architecture as a Bachelor of Arts (BA), however, in the future a more scientific Bachelor of Science (BSc) or hybrid qualification may be needed to ensure future professionals have the correct range of skills. This correlates with the original aims of the RIBA which was established for; *"the purpose of forming an Institution for the general advancement of Civil Architecture, and for promoting and facilitating the acquirement of the knowledge of the various arts and sciences connected therewith"* (RIBA, 2016, p. 2). This original Charter confirms that architecture was invested in the arts and the sciences and also for the furtherance of Civic architecture – one that works for the whole of society. Data-driven design provides an opportunity to rediscover these values for greater societal good and increased standing of the profession. This represents an opportunity for the RIBA to refocus on its core objectives of art and science in architecture, not just good design, and realign itself closer to its core values.

The use of data, the complexity of managing data, and the new skills required suggests that a new data integrator and manager role may be required. This would have an impact on the current role for Architects as they are not trained to understand coding, data, or esoteric programming skills to interrogate this at present. Therefore this data supports Garber (2014, p. 13) who argued that as; *"today's digital tools expand, rather than constrain, the authorial and ambit of Architectural design"*. The participants appeared to agree with this and many were performing this specialist role themselves, usually as a BIM Manager, representing a loss to the profession. It appears that this was a result of projects they were working on requiring detailed support and data management skills which were lacking within the architectural practices they were based.

An area that was mentioned often was a loss of design control for Architects and how technology and data-driven methodologies may affect this. Styhre and Gluch (2009, p. 232) investigated this fear

of a loss of creativity within the Architect's role; *"For the Architects, creativity is rather threatened by the day-to-day routines, which gradually and at times unnoticed push the creative activities into the margins of the work, thereby slowly rendering the daily work devoid of the highly praised creative endeavours."* The analysis is very useful as it demonstrates that the focus of design within the role of Architect is not as prevalent as perceived. A finding of this research is that data-driven design should be to automate the mundane, and use what Schwab (2016) discusses as machine learning, to enable greater focus on the design work. This appears to be a key finding of this research, that creativity can be enhanced through automation of standard tasks to enable a focus on creativity and design, not the opposite.

The challenge that Architects experience in their role can be communicated as; stay the same, or adapt, change and adopt data-driven approaches, or change role and become more of a data expert or BIM Manager. Without change in the profession, new professionals will emerge that can harness the data and apply it in a way that is both creative/objective and artistic/scientific, and leave traditional architectural practice.

Models

A model has been presented that links the research questions together to explain the findings (see Figure 4). The model illustrates the four role areas that Architects could develop into as well as combining the data-driven conceptualisation and the competencies that may be required in the future around this. The rings describe the three research questions and the diagram has the Architect profession as central to this and focusses in on the role options available, depending on the level of adoption of data-driven design principles.

The benefits of this model are that it illustrates the research findings in one diagram and allows communication to a wider audience quickly and easily of findings. It also illustrates that the role of Architect is central to the adoption of future skills. For example, an Architect may adopt a hybrid approach and start to understand the data-driven design skills required and then understanding the conceptualisations that underpin this. They will then be in a position to develop as a professional in this area. The model is useful as a framework or roadmap for Architects to understand how specialists in the field of data-driven design understand their skills.

Figure 4: Data-driven design model

A further model has been presented that illustrates the level of potential marginalisation through stasis, and future relevance of the Architect (see Figure 5). The model illustrates that Architects do not appear to be able to remain as existing as they will fall behind Architects which have these skills. The skills are arrayed around the new roles to demonstrate that these will need to be added, in addition to the existing skills that Architects have. However, as discussed there is an opportunity for Architects to move into new roles and the skills are essential if this is to be undertaken.

Figure 5: Marginalisation model

The model demonstrates that increased influence within data-driven design is predicated on acquiring the new skills that have been identified. With the greater acquisition the skills will come the increased likelihood of adopting, first hybridisation, then moving into a BIM data manager role and then finally the move to a new role entirely. Fundamentally, stasis is divorced from this process and represents future marginalisation as the profession continues forward meeting future needs without them.

5. Conclusions and Future Work

This research will benefit Architects that are exploring how new technology and processes may impact on their role and skills. Question one explored how data-driven design was conceptualised, with the outcomes demonstrating frustrations with existing ways of working. It was proposed that Architects could benefit by adopting a more scientific approach that utilises diverse data sources, moving away from the traditional practices of experiential and intuition based decision-making. The use of diverse, data sources should allow greater design options to be created based around empirical information. Furthermore, many of the participants expressed a desire for optimisation of the process of delivering a building to increase the automation and speed of delivery. This aligned with the Construction 2025 (HM Government, 2013) aims and objectives and illustrated that the participants are at the forefront of modern problem-solving in their practices. Leadership was seen as a fundamental requirement for Architects which participants felt was lacking. Furthermore, there was a necessity to update existing education criteria from the ARB and also increase data skills for professional continual research and CPD to upskill Architects.

Question two illustrated that new skills are required by Architects to meet existing and future needs. The technology available to Architects now means that there are opportunities for new skills to be adopted. Some of these skills were recognised as already required, such as research and innovation in the construction industry. However, new skills will also be required; data synthesis skills, data informed analytical thinking skills and data management skills. These are new areas that Architects could develop and understand either as a team leader or as a team member utilising them themselves. If these skills are adopted, Architects may become a hybrid profession that is both artistic and scientific in its approach. The creative and design focused approach that Architects have traditionally will be maintained, however this needs to be augmented with data and analytical thinking skills. A hybrid profession would be well placed to meet the needs in the future. Unfortunately, many of the participants discussed that the traditional nature of Architects, with a resistance to change and a fear of new technology, may result in stasis. This suggests there is a risk that this route will not be adopted and lead to fragmentation.

Question three asked what impact will data-driven design have on the future role of Architects? Hybridisation of the architectural role was discussed with the data integrator and data manager role currently being undertaken by Architects who have moved into a BIM Manager role within their organisations which has led to a loss of this particular role to the profession. The last point is the most critical; Will Architects be able to adapt and change or will they remain in their current guise? If the latter is the case then the creation of a new data-driven professional role may be the result and would pose a threat and marginalisation to the existing traditional Architect as they can develop new efficient proposals. A new role would be able to apply data faster and create more effective results as the data will support better decision-making. If Architects are unwilling to change there exists an opportunity for a new role to evolve and become a hybrid which is incorporated into current activities. However, equally there is a risk that non-adoption will result in stasis and the loss of an opportunity to develop and evolve, resulting in stagnation and the inability to respond to future challenges.

Concluding Statement

The research undertaken has demonstrated that data-driven design is an emerging and valid area of architectural practice. It is clear from the results that the impact on the industry could be significant and there is a risk to Architects who do not develop an understanding of data-driven design being unable to fulfil future creative, societal and governmental requirements. The themes that emerged have

communicate that Architects in the future will need to be informed by data and also there is an opportunity for new roles and professions to emerge. The major research outcome is that a new role is emerging which is a key research finding and could impact the construction industry at a wider scale. The question of how data-driven practices affect other consultants and practitioners within the construction industry is potentially an important development. It appears that Architects can re-establish themselves as professionals fulfilling the original RIBA Charter aims of a profession focussed on the "*general advancement of Civil Architecture, and for promoting and facilitating the acquirement of the knowledge of the various arts and sciences"* (RIBA, 2016, p. 2). Conversely Architects could face further marginalisation with new roles developing without them.

References

Airaksinen, M. (2016). Research Roadmap Report Smart City Vision. Rotterdam. Available at: http://site.cibworld.nl/dl/publications/CIB Publication 407 (Accessed: 1 August 2017).

ARB (2012). ARB Criteria at Parts 1, 2 and 3. Available at: http://www.arb.org.uk/wp-content/uploads/2017/11/ARB_Criteria.pdf (Accessed: 1 April 2018).

Architect's Registration Board (2017). The Architect's Code: Standards of Professional Conduct and Practice, p. 20.

Bernstein, P. (2017). 'False Binaries', archpaper. Available at: https://archpaper.com/2017/03/phil-bernstein-practice-values-false-binaries/ (Accessed: 6 August 2017).

Clark, T. (2015). Architects welcome RIBA plans to strengthen chartered criteria., Architect's Journal. Available at: https://www.architectsjournal.co.uk/home/architects-welcome-riba-plans-to-strengthen-chartered-criteria/8683850.article (Accessed: 16 March 2018).

Constructing Excellence (2015). Lean Construction, Constructing Excellence. Available at: http://www.constructingexcellence.org.uk/pdf/fact_sheet/lean.pdf (Accessed: 1 April 2018).

Cottrell, S. (2014). Dissertations and Project Reports. London: Palgrave Macmillan.

Derbyshire, B. (2014). A new vision for architecture, Building, February. Available at: http://www.building.co.uk/communities/construction/housing/a-new-vision-for-architecture/5066575.article (Accessed: 20 August 2017).

Deutsch, R. (2017a). Convergence: The Redesign of Design. Chichester: Wiley and Sons.

Deutsch, R. (2017b). Data-Driven Design and Construction. New Jersey: Wiley and Sons.

Farmer, M. (2016). The Farmer Review of the UK Construction Labour Model: Modernise or Die, Construction Leadership Council. London. Available at: http://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2016/10/Farmer-Review.pdf (Accessed: 1 April 2018).

Garber, R. (2014). BIM Design. Chichester: Wiley and Sons.

Gauchat, U. (2009). The $300,000/year architect, Architectural Design, 79(2), pp. 32–37. doi: 10.1002/ad.847.

Jamieson, C. (2010). The Future for Architects, RIBA. Available at: http://www.buildingfutures.org.uk/projects/building-futures/the-future-for-architects/the-future-for-architects-report/ (Accessed: 1 August 2017).

MacKinnon, K. (2017). 'Report - RIBA Student Destinations Survey 2017', RIBA. London. Available at: https://www.architecture.com/-/media/gathercontent/riba-student-destinations-survey/additional-documents/reportribastudentdestinationssurvey2017pdf (Accessed: 1 April

2018).

Miller, N. (2017). Autodesk's BUILD Space Highlights the Need for Research in the Design Community, Architect. Available at: http://www.architectmagazine.com/technology/autodesks-build-space-highlights-the-need-for-research-in-the-design-community_o (Accessed: 4 August 2017).

Nowell, L. S. et al. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria, International Journal of Qualitative Methods, 16(1). doi: 10.1177/1609406917733847.

Ottchen, C. (2009). The Future of Information Modelling and the End of Theory, Architectural Design: Closing the Gap, 79(2), pp. 22–27.

Peters, B. (2013). Computation works: The building of algorithmic thought, Architectural Design, 83(2), pp. 8–15. doi: 10.1002/ad.1545.

Reason, P. and Bradbury, H. (2006). Handbook of Action Research, Participative Inquiry and Practice, London, p. 468. doi: 0432.

Schwab, K. (2016). The Fourth Industrial Revolution. Geneva: World Economic Forum.

Styhre, A. and Gluch, P. (2009). Creativity and its discontents: Professional ideology and creativity in architect work, Creativity and Innovation Management, 18(3), pp. 224–233. doi: 10.1111/j.1467-8691.2009.00513.x.

Susskind, R. and Susskind, D. (2015). The Future of the Professions. Oxford: Oxford University Press.

Young, E. (2015). Fit for purpose? RIBA Journal. Available at: https://www.ribaj.com/intelligence/riba-appointments-skills-survey-report (Accessed: 1 April 2018)