EVIDENCE-BASED ARCHITECTURAL DESIGN

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Abstract

Much of 19th century city planning has been characterised as successful solutions to problems usually or often in public health. In the 20th Century public health has seen a change in balance from communicable diseases such as tuberculosis to non-communicable diseases such as diabetes. This change has been shown to be related to changing life styles and in particular to how social hierarchy and organisation empower or disempower individuals. Failing to meet the fundamental human needs of autonomy, empowerment, and human freedom is a potent cause of ill health. Architecture was heavily influenced by the state of scientific and medical knowledge. The Garden City movement and early Modernism were rooted in the discovery that sunshine kills germs. However, current architectural 'theories' about Urban Design and spatial structure and their impact on the people who inhabit cities are not based on such solid evidence. At the same time architects have continued to lose market share due to loss of client focus.

In recent years there has been a significant change in the way medical doctors are trained. There has been a shift from the traditional, subjective and judgement-based treatment to an explicitly evidence-based approach, involving the conscious application of scientific theory. This approach now forms an important part of medical education and training. Architects of healthcare facilities were forced to adopt the evidence-based approach. Although its use has expanded slightly the profession at large has not adopted it. The approach continues to be conspicuously absent from architectural education.

Based on a literature survey, the main part of the paper describes the nature of evidence-based architecture and how it is done by leading practitioners and how to evaluate evidence in published papers.

In conclusion, the paper argues that if architects wish to continue to play as prominent a role as in the past, different skills will be needed in future. Evidence-based design will be one.

Keywords:

Evidence-based design, evidence-based architecture, client requirements, architectural education

1. INTRODUCTION: EVIDENCE-BASED ARCHITECTURAL DESIGN: WHAT IS IT?

Every architect has experienced having a question but not knowing the answer. The resulting search, once it has exhausted local resources of colleagues, reference material and completed projects, must explore more remote sources of information. The farther one has to stray from one's comfort zone, the more ill-at-ease and reluctant one becomes:

> "(Architects) ... tend to seek written information as a 'last resort' when their own experience or that available in the office fails to give either an answer to a problem or the understanding to enable a solution to be worked out." (Mackinder and Marvin, 1982).

An answer might not be found, nor even exist: it might have to be established by research.

Evidence-Based Design (EBD) reduces the frequency and impact of such occurrences. It links design decisions to verifiable outcomes. Whether at conceptual or later stages in design, with EBD a key design hypothesis must be supported by specific evidence from identified sources. It is normal to record the eventual outcomes of design decisions of completed projects and to feed this evidence back into later designs. This tends to make the design more original and creative rather than less so.

EBD also puts the architect into a much closer working relationship with the commissioning client and eventual users. A client interviewed for the RIBA Strategic Study who was asked, "How can you get the best out of an architect?" replied,

> "Ban him from the drawing board for the first month, and **get him to understand your business**." (RIBA Strategic Study, 1994).

As Hamilton and Watkins (2009) put it, "The specialized knowledge associated with the client's activity or business will be critical to the designer's success."

Here is their definition of EBD :

> "Evidence-based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project."

Every word of this subtle statement is important. Use of *evidence* is fundamental. EBD is a *process*, that is a way of designing, where the same evidence can easily lead to different decisions depending on the context. EBD is *conscientious* because it is thorough and puts the client's interests first, *explicit* because the process and outcomes are subject to scrutiny, *judicious* because in examining a piece of evidence is, it considers its source, research method credentials, appropriateness and applicability. EBD concerns *critical decisions* because it is focused on specified outcomes explicitly valued by the client or users. EBD usually begins before the architect starts to design. After completion and occupation of the building follow-up research and measurements are conducted in order to record evidence on how the design performed against the predicted outcomes.

Many architects deal with gaps in their knowledge by avoidance. They do something they know will work adequately rather than search for information. However, without the nourishment and stimulus of new knowledge, architectural creativity tends towards the eclectic, empty "rootless formalism" condemned by Martin (1967). Truly creative design that yields significant benefits for clients and users is likely to come from better information, underpinned by high quality evidence:

> "This means not relying on outdated information or ignoring new information. It means seeking out the most reliable information about any important topic that could influence a key design decision. This requires an understanding of what makes research findings credible. It means staying current with your own field as well as the field of your client. Most importantly, it means looking for credible information in new places where you have not previously been accustomed to searching.
>
> … Particular attention should be paid to domains of knowledge that are not your current areas of expertise. It is often the unusual information from an unexpected source that will

stimulate the most innovative concept for the project." (Hamilton and Watkins, 2009).

Evidence-based practice originated in medicine with a paper by Cochrane (1972). He argued that medical practice was subjective and did not always yield the best outcomes for patients: treatment based on reliable evidence would give measurably better outcomes. Evidence-based practice developed rapidly in the medical and healthcare areas, and the approach has now been adopted world-wide. Doctors have shifted from the – architect-like – traditional, subjective and judgement-based treatment to an explicitly evidence-based approach, involving the conscious application of objective knowledge. The approach now forms an important part of medical education, training and practice.

When commissioning buildings medical people demanded the same rigour from their consultants. Architects of healthcare facilities were forced to adopt the evidence-based approach. Although its use has expanded slightly the profession at large has not adopted EBD. Such an approach continues to be conspicuously absent from architectural education which seems incapable of re-inventing itself in any meaningful way in spite of numerous conferences on the subject.

2. EVIDENCE-BASED ARCHITECTURAL DESIGN: WHY DO WE NEED IT?

2.1 Growth of knowledge about architecture and planning

Much of 19th century urban planning involved devising solutions to problems brought on by high rates of urbanisation and immigration. The problems were solved thanks largely to research and to the rapid development of science and technology.

> "City engineering and city planning developed as attempts to exploit available city-building technologies and, later, to invent new ones. … to dispose of wastes, to supply sanitary water, to build intra-city transportation systems, to provide schools and hospitals, and even to build tolerable housing of some quality for everyone.
>
> ... Epidemics of the dread diseases are gone. Obnoxious spill-overs from factories to adjacent houses have been largely eliminated. Producers are accessible to their suppliers and customers, and retail outlets are accessible to residents. The majority of the cities' residents can live with a sense of decency and some even with dignity. Our cities do work. If we knew how to measure their overall efficiency, they would probably score pretty high." (Webber, 1969).

Architects learned a great deal from working in this virtual laboratory of public health and became skilled in matters beyond construction. The Garden City movement and early Modernism followed on from Pasteur's discovery of germs, and especially, the revelation that they can be killed by sunshine.

Webber predicted that the trajectory of public health would change direction in the 20th century:

> "... the increasing pace of history is revealing a new set of problems, differing in kind from those that have been occupying city planners. During the industrial age, the [planning] profession's work was aimed at improving the cities' efficiency. In the imminent post-industrial age, unprecedented wealth will turn the equity issues into imperatives. Growing disparities in levels of wealth and welfare among increasingly diverse publics are likely to engender severe conflicts both within the highly developed nations and between the wealthy and the poor nations." (ibid).

Forty years after Webber wrote the above Marmot (2006) has confirmed his predictions. Public health has changed from fighting communicable diseases like tuberculosis to preventing non-communicable diseases like diabetes and heart disease. These arise from changing life styles i.e. work and travel patterns and also to how social hierarchy and organisation empower or disempower individuals. Research shows that the unnecessary disease and suffering of disadvantaged people,

whether in poor countries or rich, is a result of the way we organise our affairs in society and the built environment. Failing to meet the fundamental human needs of autonomy, empowerment, and human freedom is a potent cause of ill health. (ibid).

2.2 Architects' knowledge about the external built environment

Thirty years ago Donald Schön, told an audience of architects,

> "The attitudes we inculcate in students are what are ultimately important. **We build in theories about spatial behaviour so we ought to know about it**." (Schön, 1984).

Architects do not know these things. Architects talk the talk about spatial behaviour and the external environment but our training does not equip us technically to design the external environment. Though a few practices have specialised in the area, environmental design is peripheral to the concerns of the architectural profession at large and formally absent from its education.

Architectural 'theories' about urban design and spatial structure and their impact on the people who inhabit cities rarely have an evidential basis. Indeed, one might go so far as to say that architects' preoccupation with so-called 'theories' insulates them from objective evidence. Most practice is intuitive and fairly subjective, and rarely burdened by new knowledge.

The author has argued elsewere that this state of affairs is due to the dominance of studio in teaching (Ó Catháin and Mann, 2008). Instead of developing a scientific knowledge base like other professions, architectural education continued to concentrate on studio projects, with little reference to external information (Ó Catháin, 2013). Possibly in an attempt to develop a more intellectual view of design, university curricula gradually dropped 'Theory of Architecture' courses and began to offer instead 'History and Theory' courses, consisting of contingent − and for the most part entry-level − compilations of diverse topics and competing 'theories' that differed between individual professors and schools, echoing the 'battle of the styles' of the nineteenth century. These different 'theories' owe their existence to the space opened up by Postmodernism whose links to Fascism are not emphasised (Wolin, 2004).

A great deal of information is now available that architects could seek out and apply. Gebel et al. provide a sample of the sort of evidence-based knowledge which architects should be using. They analysed more than a hundred peer-reviewed articles published since 1980 containing evidence on change in physical activity resulting from interventions in the environment. They concluded,

> "... Overall, there is some evidence that improving the built environment (street connectivity in neighbourhoods, mixed land use, promoting pedestrian access to city centres, and traffic calming) may influence incidental physical activity, and there is stronger evidence that trails and path development may influence total physical activity levels. In particular, the evidence tentatively points to these interventions fostering 'incidental' or lifestyle activity, and these effects may be reaching marginalized and disadvantaged groups. … **This is of major public health significance,** as many physical activity interventions reach the more educated in the population, often already with high intentions to exercise." (Gebel et al., 2005, emphasis added).

Danish architects engaged in urban design are pioneering new roles for themselves and offering new types of services:

> "… these architects are less frequently drafting masterplans of new districts and more often leading or contributing to multi-disciplinary project processes that frequently blur the boundaries between urban research, policy making and form making. … It also marks a shift from the traditional, isolated role of the architect to a multidisciplinary and collaborative working method. …
>
> Unlike many urban design firms, Gehl Architects' services are primarily research based

rather than design based. Their project deliverables are handbooks that communicate the research results and make recommendations based on the urban research. These products are unique because they aid in the development and evolution of urban environments, rather than dictating idealized and static urban conditions. Their work can be further differentiated from formal approaches to urban design because it considers public life and human behavior to be the most important aspect of urban environments. Open spaces and buildings play supporting roles to the human life that takes place within them." (Sullivan, 2006).

2.3 Views of clients, users and others

At the Bristol, Conference on Architectural Education, Professor John Tarn quoted a strong criticism:

> "We must begin by destroying the illusion that architects are necessary. … Architects have conned us into an exaggerated view of their significance … but for the most part they are as dispensable as dress designers, and are as dangerous." (Scruton, 1983).

Tarn warned that this statement, "... should not be ignored ," and went on to say,

> "Two things emerge … First, that we do need to produce better architecture. By that I mean architecture that works better and looks better, so that the criticisms are diminished. Secondly, I think we need to evolve a stronger theoretical and intellectual view of design." (Tarn, 1983).

At that time the new role of Project Manager and the contemporary rise of 'Design and Build' procurement were eating away at the architect's fee income and status. These changes were being driven by clients who, dissatisfied with the service the architect was providing, were going elsewhere. In the light of this there was widespread concern among architects about the survival of their architectural idea into the project as built. This indicates a contradiction between the values of the architect and those of the client. Findings from a later international study of the construction industry by CIB showed that architects were out of step with the industry and, critically, with their clients:

> "Clients are becoming well-informed, even expert at building procurement. Trying to extend or maintain the traditional responsibilities of the architect based on the interests of architects will not work in the long run. **A far better way is to take the client's needs as the starting point and to search for 'added value' for the client.** This may mean forgetting the traditional roles in the building process and accepting that there is no longer one construction market with one sort of architect.
>
> **The scope and priorities of clients are changing, and this is the only important thing for architects.** Clients are becoming more precise in defining their requirements and orientated towards higher quality. … There will be a shift in their employment of architectural services from local to national. Some will even search internationally for the right architect. There will be another shift from using general practice to higher quality and to specialist, innovative practice. In the light of this architects will have to position themselves, and the service they offer, along three strategic axes: type of market, level of technology, type of design service.
>
> ... In order to work with professional clients who have complex projects, the architect will need **different skills, different knowledge and different attitudes.**" (Bakens, 1995, emphasis added).

An excerpt from the RIBA Strategic Study suggested a number of things architects should be doing, including monitoring user research and property trends. It advised: "… **the future will include more pre-design research time.**" (RIBA Journal, March 1995, p53). Although those studies are now twenty years old, they are still broadly representative of the state of the profession internationally.

We should be asking why this is the case, why we have not moved on.

More recently, the author received following observations from someone who interviewed a number of prospective architects for a new house commission:

> "When I was told of the various houses and/or buildings that had been designed by each architect and given to understand that each had been 'successful' □ I asked the simple question, 'have you gone back to the client and checked that their aspirations and your belief that it is working successfully is really correct?' In no case was there any follow-up. It seemed to be assumed that as it was designed therefore it was successful. Critical review to ensure project success was frowned upon." (Erasmuson, 2007).

That attitude is still widespread. Today's experienced and financially aware clients can be expected to favour the architect who understands the importance of measurable outcomes, who is research-led, who makes use of existing knowledge rather than ignoring it, who seeks out and makes use of external inputs when appropriate, and especially, who minimises risk to the project from hunches and guesswork.

Changes such as Building Information Modeling (BIM) represent a major improvement. BIM cuts across professional boundaries and forces early consultation and cooperation of the kind envisaged by Bakens, though the state of the industry is still inhibiting progress.

> "BIM is outstripping the availability of quality database information to inform the simulation and modeling outcomes. Much of this challenge is connected to the lack of an infrastructure within the design and construction disciplines and professions for creating, archiving and sharing data. Put more simply, it is the lack of a research tradition in both the academy and in practice that underpins this challenge." (Brandt et al., 2010 p13).

3 EVIDENCE-BASED ARCHITECTURAL DESIGN: HOW DO WE DO IT?

3.1 Asking questions

We add to our knowledge by asking questions and then seeking answers. It is important to ask questions in such a way that they are answerable by reference to evidence. They have to be constructed with this in mind. Formulating good, answerable questions is crucial in order to access the appropriate data or research.

It is helpful to classify questions into two categories, "background" and "foreground" (Straus et al.). "Background" questions concern **general knowledge** that would help understand the issues. When well formed, such questions usually have two components:

1. A question root (who, what, when, where, how, why) with a verb.
2. An aspect of the thing or condition of interest.

An example question might be: "What causes corrosion and how could it be be eliminated?" In finding the answer the architect will gain valuable background knowledge. Architects are not normally taught about the electrochemical series and are generally not aware that corrosion is the result of electrical action. This realisation can prompt a more sophisticated (and defensible) study of roof or façade details that involve ways of separating electrically dissimilar metals, rather than copying published standard details without understanding how they work.

"Foreground" questions concern **specific knowledge** that could directly inform one or more "foreground" decisions faced by the designer, including a broad range of human, technical and financial issues. When well formed such questions usually have four components (PICO is a mnemonic widely-used in the medical literature):

- **P** The **Problem** of interest
- **I** The main **Intervention** contemplated, defined very broadly

- **C** a ***Comparison*** intervention (also defined very broadly)
- **O** The **Outcome** of interest, including a time horizon, if relevant.

An example might be, "For a seaside location where there is a high risk of salt water entering the construction (P) due to wind and rain but negligible risk of frost damage, how does a copper-clad façade (I) compare with brick construction (C) over a design life (O) of twenty-five years?"

3.2 Capturing, scheduling and selecting questions

Questions need to be recorded and kept in a standard form for later retrieval and investigation (Staus et al., p19) since it will not usually be feasible to try to answer them on the fly at the time they crop up. They need to be labelled with a cut-off date when the answer is needed. Questions will vary in importance in relation to client priorities, project outcomes, personal learning, feasibility. The architect can use these criteria to assign priority.

3.3 Answering questions

To locate the best evidence the following strategy is adapted from Dawes et. al. (p16ff):

1. What sort of **question** is it? (foreground/background, procurement, materials, risk-benefit, cost-effectiveness, defect prevention) The answers will come from different areas with widely differing levels of reliability.
2. What sort of **information** would provide evidence to answer this type of question? We should start at the highest level of reliability and work down until our search is satisfied.
3. What sort of **study** would provide such information? Again, we should start by looking for studies at the highest level of reliability and work down.
4. What sort of **resources** would give us access to such studies? As well as primary source research reports there are also bibliographical sources of abstracts, reviews and so forth.

In view of the marked reluctance of both the architectural profession and the building industry to fund or engage in research the higher levels are likely to be sparse. We may be reduced to using anecdotal evidence, case studies or even academic theses as being the best available.

3.4 Exploring the information jungle

> "The need to develop new skills in seeking and appraising evidence cannot be underestimated. And, the need to develop and apply these skills within the time constraints of our clinical practice must be addressed." (Straus et al.).

Exactly the same applies to an architect. Fortunately the current generation of students is very accomplished at working with computers and searching.

The architect may think he already knows a lot with certainty. Nevertheless, it is necessary to recall that **certainty does not imply correctness, appropriateness or reliability**. Information must be used in a professional way. That means making judgements about its quality, bias and applicability. We need to be able to assess the evidential value of the information we retrieve, whatever the source. There is a spectrum of trustworthiness ranging from the unsolicited mailshot to the gold standard of Randomised Controlled Trials. Bias is any factor, recognised or not, which distorts the findings of a study. Architects may have difficulty in recognising bias, since their training tends to encourage it.

3.5 How to evaluate a research paper

Evidential value is usually determined by the 'research design' i.e. the procedure followed in the original research. According to Dawes et al., (pp47/48):

"The aim of critical appraisal is to identify the quality of an article. There are three key issues to think about when appraising any paper:

- Are the results of the study valid?
- What are the results?
- Are the results relevant?

…

Start with easy questions e.g. Have the authors answered the question the research was designed to study? The art of appraisal is to assess not whether a paper is "rubbish", but whether there is so much potential bias that the results are no longer valid. That … is the essence of appraisal.

..."

Five levels are imputed: Level 1, the highest, yielding the strongest evidence, comes from systematic reviews of controlled randomised trials. Intermediate levels come from non-randomised or individual studies and case studies. Level 5, the lowest, is attributed to mechanism-based reasoning (Oxford Centre for Evidence-Based Medicine Levels of Evidence Working Group, 2011).

Maqardt and Motzek (2013) provide a useful table for architects wishing to evaluate a research report. It follows the above model but adds a new Level 6, below the lowest evidential level, reflecting the almost mortifyingly low level of evidential value of much architectural knowledge.

Table 1: Levels of Evidence for Healthcare Design. Source: Maqardt and Motzek, from Stichler (2010).

Level 1 *(Best)*	Systematic reviews of multiple randomized controlled trials (RCTs) or nonrandomized studies; meta-analysis of multiple experimental or quasiexperimental studies; meta-synthesis of multiple qualitative studies leading to an integrative interpretation.
Level 2	Well-designed experimental (randomized) and quasi-experimental (nonrandomized) studies with consistent results compared to other, similar studies.
Level 3	Observational studies, well-designed qualitative studies, integrative or systematic reviews of observational or qualitative studies, or RCT or quasi-experimental studies with inconsistent results compared to other, similar studies.
Level 4	Professional standards or guidelines with studies to support recommendations.
Level 5 *(Worst)*	Opinions of recognized experts, case studies.
Level 6 *(Worse still)*	Recommendations from manufacturers or consultants who may have a financial interest or bias.

They have also provided two easy flow charts, one for an individual piece of research and one for a review of multiple investigations. The author has refined and amalgamated them in Figure 1.

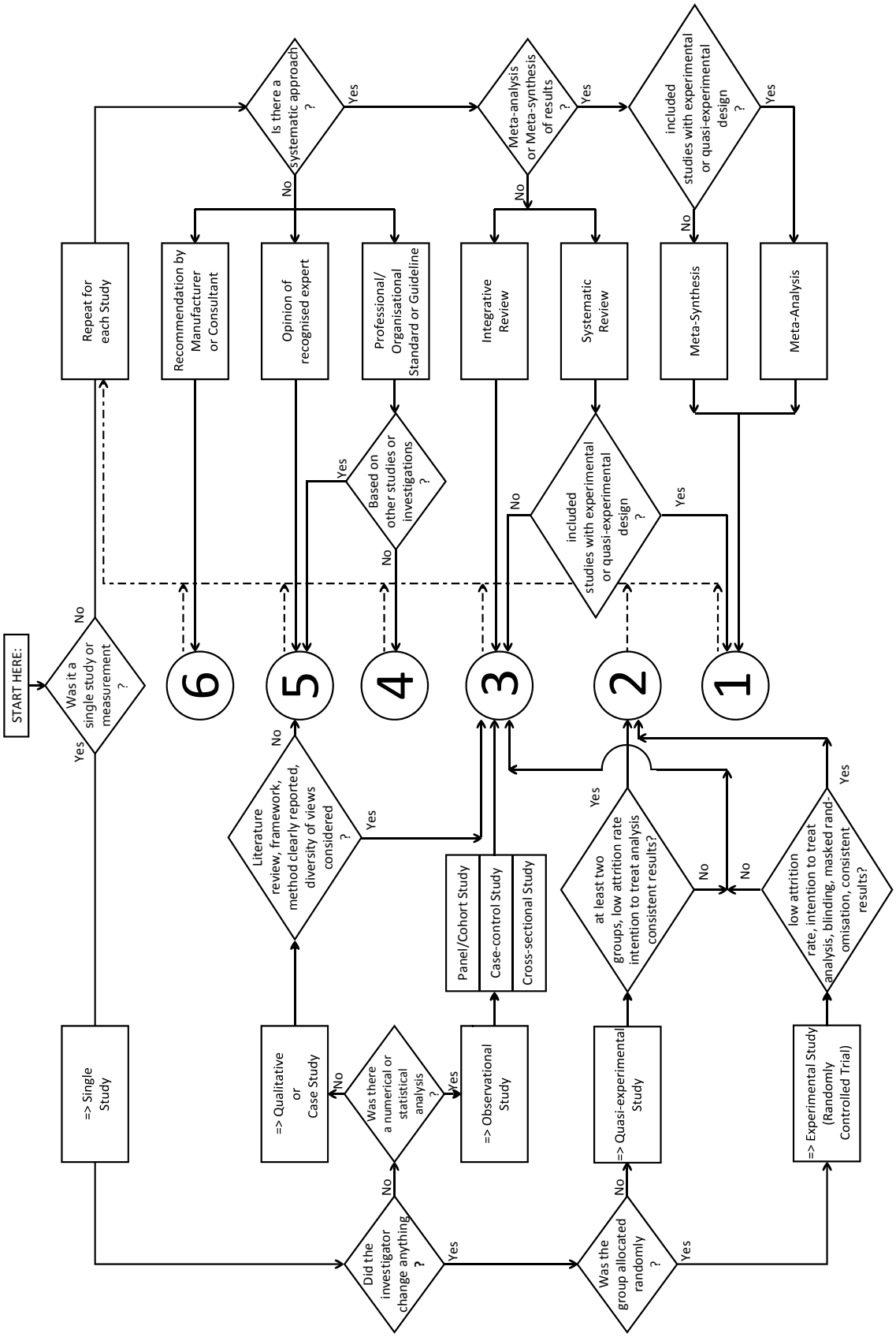

Figure 1. Flowchart for determining Level of Evidence of a document (after Maqardt and Moztek).

3.6 Actually doing it

Healthcare providers, consumers, researchers, and policy makers are inundated with information. It is unlikely that all will have the time, skills and resources to find, appraise and interpret this evidence and to incorporate it into healthcare decisions. “Cochrane reviews” respond to this challenge. They are voluntary collaborations for identifying, appraising and synthesizing research-based evidence and presenting it in a standard format. The main resource required by authors is their own time.

It is unlikely that many architects will engage in full-blown systematic reviews but one can imagine the difficulties a junior architectural assistant might have, when trying to assemble the best information available to answer a particular question: he or she could be up against an unsympathetic superior, trained in the old way, who does not yet understand either what systematic reviews entail, or their importance, perhaps not fully appreciating the value of keeping up to speed with the client.

Architects may feel that this paper is too critical of the profession (or indeed that the evidence presented is not of sufficient quality!), and protest that they use evidence in their work daily. The author invites them to compare their current practice against Table 2, which illustrates what EBD is like at different levels of accomplishment. Most architectural practice does not even comply with the lowest level.

Table 2 FourLevel model of Evidence-Based Design (after Hamilton, 2003 with later additions).

☆☆☆☆	**Level 4 practitioners – Peer Review** • Publish their findings in peer-reviewed journals • Collaborate with academic social scientists • Subject their work to the highest level of rigorous review
☆☆☆	**Level 3 practitioners – Unbiased Reporting** • Report results publicly through writing or speaking • Share information beyond the firm or client team • Subject methods and results to scrutiny from others
☆☆	**Level 3 practitioners – Hypothesis and Measurement** • Hypothesize the expected outcomes of design decisions • Measure the results • Employ new design methods • Understand the research and interpret the implications • Are able to connect the decision to a measurable outcome • Resist the temptation to report success and downplay failure
☆	**Level 1 practitioners – Critical Interpretation of Research** • Stay current with literature in the field • Follow the evolving environmental research related to the physical setting • Interpret the meaning of the evidence as it relates to specific projects • Make judgments about the best design for specific circumstances • Use design concepts based on benchmark reviews of other projects • Produce work that advances the state of the art by developing tangible examples of improved design

We are used to searching for information that demonstrates that our hypotheses is right or could work. However, in order to eliminate bias we also need to search for information that would prove us wrong. This can be very uncomfortable, but if done diligently can lead to one's being able to place more confidence in a design decision since it reflects a broader range of information with less bias.

3.7 Qualitative Research

It would be wrong not to mention this. Architects are more likely to be familiar with this approach and, at least superficially, more comfortable with interpreting results. Qualitative Research is appropriate when we want to "understand perceptions, motives and actions of individuals and organisations" (Boulton & Fitzpatrick 1997). It can be very good at providing the perspective of the user and can generate new theories. Methods include interviews, observation, documentary study. It is complementary to quantitative research. In many cases of interest to architects it may be the only research available.

The following characterisation is adapted from Dawes et al. (p120ff).

1. Privileging subjective meaning:
   Does this research, as reported, illuminate the subjective meaning, actions and context of those being researched?
2. Evidence of responsiveness to social context and flexibility of design:
   Is there any evidence of the adaptation and responsiveness of the research design to the circumstances and real-life social settings met during the course of the study?
3. Evidence of theoretical or purposive sampling:
   Does the sample produce the type of knowledge and processes within which the individuals or situations are located?
4. Evidence of adequate description:
   Is the description provided detailed enough to allow the researcher or reader to interpret the meaning and context of what is being researched?
5. Evidence of data quality:
   How are the different sources of knowledge about the same issue compared and contrasted?
6. Evidence of theoretical and conceptual adequacy:
   How does the research move from a description of the data, through quotations or examles, to an analysis and interpretation of the meaning and significance of it?
7. Potential for assessing typicality:
   What claims are being made for the generalisability of the findings to other bodies of knowledge or to other populations or groups?
8. Relevance to policy:
   Is the relevance of research to a variety of different stakeholders clearly indicated?

4 CONCLUDING OBSERVATIONS

If architects want to play as prominent and important a role as they have in the past, then they need to change their existing attitudes and working practices and broaden their skill set in order to provide the kind of service that is now required. Adopting an evidence-based approach would be a good way of achieving this. There is a lot of valuable design evidence to be found in medicine-related and, increasingly, in other databases and sources. Clients and users will expect architects to use this. Its everyday application will require a considerable shift of attitude on the part of the architectural profession and its education system. The biggest shift is likely to be the embracing of evidence-driven research by architects and its routine incorporation as a part of normal design. 'Research' has to mean more than photocopying from the architectural equivalent of "Hello" magazine. It has to mean active engagement with – and the creation of – new knowledge, learning from whatever source, as

well as learning by doing and sharing knowledge with others. This applies to architects, whether they are designing single buildings for the more discerning private client, or making large-scale interventions in the external built environment.

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