

# Skills-Knowledge-Attitude-Training-Experience (SKATE) in 'Designing for Occupational Health of Construction Workers'

Final report February 2019

**Dr Patrick Manu**

The University of Manchester

**Professor Alistair Gibb**

**Dr Carolyn Drake**

**Dr Wendy Jones**

**Dr Phil Bust**

Loughborough University

**Dr Abdul-Majeed Mahamadu**

University of the West of England

**Professor Michael Behm**

East Carolina University

# Contents

|  |            |
|--|------------|
| 1. Acronyms                                    | <b>ii</b>  |
| 2. Executive Summary                           | <b>iii</b> |
| 3. Acknowledgements                            | <b>iv</b>  |
| <hr/>  |            |
| 4. Research Background                         | <b>1</b>   |
| 5. Research Scope and Methodology              | <b>2</b>   |
| 6. Findings                                    | <b>3</b>   |
| 7. Conclusions                                 | <b>11</b>  |
| 8. Design for Health SKATE Key Recommendations | <b>12</b>  |
| 9. References                                  | <b>13</b>  |

# Acronyms

|               |  |
|---------------|--|
| <b>CAD</b>    | Computer Aided Design  |
| <b>CDM</b>    | Construction (Design and Management) Regulations             |
| <b>CPD</b>    | Continuing Professional Development                          |
| <b>DfHTG</b>  | Design for Health Task Group                                 |
| <b>DIY</b>    | Do-it-yourself   |
| <b>HAVS</b>   | Hand-Arm Vibration Syndrome                                  |
| <b>HCLG</b>   | Health in Construction Leadership Group                      |
| <b>HSE</b>    | Health and Safety Executive                                  |
| <b>IOSH</b>   | Institution of Occupational Safety and Health                |
| <b>OSH</b>    | Occupational Safety and Health                               |
| <b>NEBOSH</b> | National Examination Board in Occupational Safety and Health |
| <b>SKATE</b>  | Skills, Knowledge, Attitude, Training and Experience         |
| <b>SKE</b>    | Skills, Knowledge, and Experience                            |
| <b>UK</b>     | United Kingdom   |
| <b>USA</b>    | United States of America                                     |

# Executive Summary

This research was funded by B&CE's Charitable Trust. The research was supported by the Design for Health Task Group (DfHTG) of the Health in Construction Leadership Group (HCLG).



While construction workers' health has long been neglected at the expense of safety, it is now an important focus of the industry. Aligned to this, there is a growing recognition that design decisions have a major influence on the occurrence of health hazards in construction (e.g. noise, dust) that can lead to work-related or work-exacerbated conditions such as hearing loss and respiratory illnesses.

The Health and Safety Executive (HSE) requires that those designing "should eliminate foreseeable health and safety risks to anyone affected by the work (if possible) and take steps to reduce or control risks that cannot be eliminated" (HSE 2019).

The Construction (Design and Management) Regulations (CDM 2015), an important mechanism for addressing health (and safety) hazards in design, requires individuals working on projects to have relevant skills, knowledge and experience to enable them to design for health. Additionally, clients recognise the importance of designers' abilities in understanding how and why to incorporate more healthy products and processes into projects. However, to date the industry continues to struggle with the make-up of these attributes, that are essential for designers to be able to design safe and healthy projects. This is particularly the case in respect of 'Design for Health' given the long neglect of health issues in construction.

This project, designed to be a collaboration between key experts in the industry, allowed for further discussion on the key attributes required of designers to enable them to Design for Health in the construction industry (reviewing skills, knowledge, attitude, training, experience - SKATE).

Workshops were the main data collection method. However, in order to engage a broader participant sample, these were supplemented by interviews and questionnaires.

Although all workshops and interviews commenced with a brief introduction to the concept of 'Designing for Health' of construction workers, many participants appeared to fail to grasp the concept specifically, as they had a tendency during discussions to keep highlighting safety examples. Comments made by respondents strongly suggest that many design teams are still

struggling to apply the principles of the CDM Regulations to construction safety challenges, let alone occupational health challenges of construction workers. This may be due to the focus of information and training being more towards safety rather than health. Most designers were aware of the risks of falls from height and asbestos, but were less likely to be aware of other risks such as dust or noise.

The findings suggest that company size and project size were relevant with regards to an individual's levels of competence in the SKATE qualities and ease of access to other individuals with the required SKATE within teams. However, project type did not appear relevant to SKATE: there was no clear view that a particular type of project required particular SKATE. While different projects may require different solutions, the key is that designers have general health awareness to identify where and how their design decisions can make a difference.

While participants highlighted positive suggestions that could help achieve better Design for Health in the future, many also raised various limitations. Responses from a number of participants highlighted the concern about the 'unregulated', smaller residential, Do-it-yourself (DIY) self-build market. Participants also discussed concerns about challenges of Designing for Health due to competing priorities, cost constraints, design time pressures, fragmentation of the role, lack of ownership, lack of health awareness, lack of site experience and limited available guidance.

It would appear that the term 'Design for Health' could be misleading, as there was a tendency to focus only on the end user and not the construction worker. Taking into account the findings of this research, the research team suggest that greater use of the term 'Prevention through Design' (which is commonly used in the United States of America (USA)), rather than the terms usually used in the United Kingdom (UK), 'Designing for Safety', 'Designing for Health' may increase the chance that occupational health is taken as seriously as safety.

First, this report describes limiting factors in designing for occupational safety and health (i.e. mainly 'safety' and the requirements of CDM) and secondly, focuses on opportunities for designing specifically for the occupational health of construction workers.

## Acknowledgement

Appreciation is extended to the Design for Health Task Group of the Health in Construction Leadership Group for its contribution in framing and delivering the research. The research team is also grateful for the contribution of all the professionals who participated in the study.

# Research Background

The rate of total self-reported work-related ill health has been broadly flat for construction workers in recent years (Figure 1, HSE 2018). 82,000 construction workers suffered from work-related ill health (new or long-standing) in 2017/18, of which 62% were musculoskeletal disorders (HSE 2018).

Research over the last few years supports the importance of planning, scheduling and design to reduce safety hazards on construction sites (Weinstein et al 2005, Gambatese et al 2008). However, worker safety may have a lower priority than other design criteria (quality, cost, aesthetics, time etc.) possibly due to a lack of knowledge and training of the designers (Smallwood 2015, Karakhan et al 2018).

There is growing recognition that design decisions also have a major influence on the occurrence of health hazards in construction (e.g. noise, dust, hand-arm vibration syndrome (HAVS)). There is increased attention on the role of the designer in designing out or reducing risks both for the construction phase and future operational life of the facility. In order to 'Design for Health', "designers should be more aware of what actually happens during the construction phase of a project" (de Souza 2003). Not only can designers reduce the physical suffering of construction workers, de Souza argues that there is likely to also be a reduction in financial costs (de Souza 2003).

The Construction (Design and Management) Regulations 2015 require that individuals or organisations working on projects have the relevant skills, knowledge and experience (SKE) to fulfil their role. Before appointing individuals their SKE should be assessed. Industry is used to being able to depend on third party blanket assessments as required under previous versions of CDM and is struggling with how to manage this statutory part of procurement. Currently, evidence of training equates to evidence of experience and knowledge. Researchers, Horne et al (2003), found that "training to incorporate health considerations for construction workers was sparse and poorly organised". Baxendale and Jones (2000) suggested that training alone should not be the only criteria for assessment, but rather that designers should also demonstrate their knowledge and understanding of hazards and how they can be mitigated through design.

While SKE is a requirement under CDM, it is believed that those 'Designing for Health' require additional attributes, namely Training and Attitude. This request by clients has led to this study of SKATE (Skills, Knowledge, Attitude, Training and Experience).

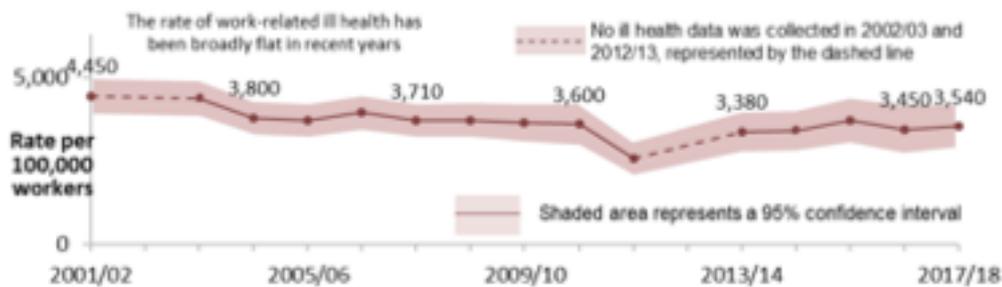


Figure 1: Changes over time. Source: LFS annual, from 2001/02 to 2017/18 (HSE 2018)

# Research Scope and Methodology

This research investigates the constituents of 'Design for Health' SKATE of individuals and project teams. Given the diverse nature of the construction sector it is acknowledged that establishing SKATE expectations for 'Design for Health' is a complex task as, even in the area of Design for Safety, the precise SKATE requirements are still being debated. This research set out to provide an understanding of the constituents of 'Design for Health' SKATE to stimulate design and client teams to make informed decisions regarding appropriate SKATE expectations.

A detailed search of literature identified very few papers specifically linking 'Design for Health' and the construction sector. The majority of papers either referred only to 'Designing for Safety', or 'Designing for Health and Safety', but in reality meaning just 'safety'.

Working closely with industry partners, the research team was a collaboration between The University of Manchester (Dr Patrick Manu), Loughborough University (Professor Alistair Gibb, Dr Carolyn Drake, Dr Wendy Jones & Dr Phil Bust), the University of the West of England (Dr Abdul-Majeed Mahamadu) and East Carolina University (Professor Michael Behm).

The planned method was a qualitative approach involving data collection from half-day 'workshops' or focus groups. Discussions would focus either on actual projects or scenarios selected to represent the various project types – This approach was intended to avoid overly generic discussions leading to 'gold-plated' expectations.

In total three workshops were conducted, recorded and analysed by the Loughborough University team. Participants at the workshops had a range of roles: client side, principal designer, contractor, other designers, and health & safety advisors.

A decision was taken not to arrange a fourth workshop as the team were concerned that the workshops were only providing access to larger organisations. Further semi-structured interviews and questionnaires (with open-ended questions) were therefore used to access people with broader experience.

Preliminary findings were then explored further with key experts. Figure 2 shows the research stages. In total 67 participants were engaged in this research all of whom were anonymised.



Figure 2: Research Stages

# Findings

Factors limiting the effectiveness of designing for both 'occupational safety and health' (OSH)

- a. Competing Priorities – end users and sustainability versus OSH of construction workers

It was evident that initial scope had an impact on the influence of priorities for the designers. Some emphasised their design work to improve the well-being of the end user and respond to environmental factors to get plans through the planning process, whilst missing opportunities to design for OSH during the construction phase.

Others discussed 'outside influencers' who have no stake in health, such as planning control staff, who insist on certain products or design approaches that could affect both safety and health, thereby solutions being fixed or limited in what designers can do. This may suggest that some external parties may attract the duties of designer, either intentionally or unintentionally. Research conducted by Lingard et al (2012) also noted the influential role of stakeholders external to the project raising challenges for design.

"design period was squeezed ... as people can't afford to take the financial risk of working on a design in case the contract fails at the last minute ... and the Client doesn't release the money until that contract is signed"

(Workshop 2)

- b. Procurement process and design time pressures were identified as counter-productive to designing for OSH, thus inhibiting design choices.
- c. Emphasis on the construction cost was also highlighted as a factor for designing for OSH not being included, or fees not supporting meetings and site visits. Design change at a later stage was also highlighted as an issue, where contractors were requesting changes to designs without realising why the original design decision was included.

"Industry demands efficiency, but the cheapest fees can win the work...Overheads are increasing but fees are reducing... The consequence being that the fees do not necessarily support site visits, especially two people visiting site, so you can't take a junior person on the team"

(Workshop 2)

"Health is seen as an optional extra...that Clients are not prepared to pay for. The "small residential sector is un-regulated, the Client doesn't want to employ professionals who are going to ask for surveys etc... They do not want to pay for anything they are not getting anything back for it. Building is an asset... they want the cheapest or quickest option"

(Workshop 2)

"Builders saying to Clients that they can save a fortune if they get rid of this or that, not realising why something has been included in the design"

(Interview, Architect)

"Health is not a primary consideration, normally it's the programme and cost"

(Interview, Contractor)

## Findings (continued)

- d. Lack of responsibility / ownership by both Client and Designer. Some comments highlighted that clients may not always be proactive on OSH, sometimes showing no knowledge or interest.

Comments suggested that for some clients the main focus was on the design brief. The criteria they impose could sometimes cause safety and health issues, but respondents suggested that they are not interested. Previous research found that improvements in the knowledge, attitude and design practices of engineers needed to be driven by the client (Miang & Chua 2016, Toole et al 2017).

From discussions it would also appear that clients may not appreciate that their decisions could sometimes be classified as design decisions.

“...developers doing self-build getting subcontractors in who are happy to be paid but neither is interested in the responsibility for the site”

(Interview, Architect)

- e. Fragmentation of the design role. For some projects, the procurement route means that designers are taking their designs to planning stage and are then no longer involved in the process, so have no knowledge of lessons learnt. Others are employed as concept designer only and are focused on selling the client a vision. This can have consequences for follow-on designers who ‘inherit’ design work at a later stage as they face challenges persuading the client that the ‘concept vision’ may not be workable. Problems regarding lack of innovation were also raised with some designers using ‘tried and tested’ methods, which may also be a consequence of fragmentation and lack of knowledge of lessons learnt.
- e. Difficulty understanding the term ‘Design for Health’. During the workshops and interviews, participants kept highlighting safety examples rather than health (with two even discussing display screen equipment (DSE) assessments in the office). There was also confusion about the scope of ‘Design for Health’, with some participants focused on the end user.

## Limiting factors relating specifically to occupational health of construction workers

- a. Reluctance to overload the client with hazard information – There was a perception that the client would not want a long list of health hazards in addition to safety hazards and controls. At least one client specified they wanted a restricted number of hazards on a list (“generally no more than five in total”).

“Well, if we’re employing a competent contractor, we shouldn’t have to tell them how to ...”

(Workshop 1)

“There are many people who will tell you something is wrong, you need to sort it out, they are the ‘police’, but getting advice on how to resolve something can be difficult”

(Workshop 2)

- b. Contractor health awareness – CDM only requires notification on risks that would not be understood by competent contractors. However, contractors’ knowledge of occupational health seems to be lower than for safety and therefore designers are not clear on what constitutes a health risk that would not be considered ‘normal’ to a competent contractor. Discussions kept referring to the contractor as “the specialist”, better placed to make decisions about health risk controls etc. Many participants suggested that designers are assuming contractors have health awareness and rely on that knowledge, so are not including potential health risks on plans unless it is something quite specific to that design.
- c. Limited guidance on eliminating health risks was also raised as an issue.

# Limiting factors relating specifically to occupational health of construction workers

- a. Reluctance to overload the client with hazard information – There was a perception that the client would not want a long list of health hazards in addition to safety hazards and controls. At least one client specified they wanted a restricted number of hazards on a list (“generally no more than five in total”).

“Well, if we’re employing a competent contractor, we shouldn’t have to tell them how to ...”

(Workshop 1)

“There are many people who will tell you something is wrong, you need to sort it out, they are the ‘police’, but getting advice on how to resolve something can be difficult”

(Workshop 2)

- b. Contractor health awareness – CDM only requires notification on risks that would not be understood by competent contractors. However, contractors’ knowledge of occupational health seems to be lower than for safety and therefore designers are not clear on what constitutes a health risk that would not be considered ‘normal’ to a competent contractor. Discussions kept referring to the contractor as “the specialist”, better placed to make decisions about health risk controls etc. Many participants suggested that designers are assuming contractors have health awareness and rely on that knowledge, so are not including potential health risks on plans unless it is something quite specific to that design.
- c. Limited guidance on eliminating health risks was also raised as an issue.

# SKATE – Skills, Knowledge, Attitude, Training and Experience for Designing for Health

The following are summaries of attributes that designers require, identified through this study. Most of these apply to designing for safety as well as designing for health, but generally this study identified a greater shortfall for health. Although comments have been split into separate elements of SKATE below, there is cross-over with many features considered relevant to more than one attribute.

## SKATE - Skills

The ability to do something well, expertise, practice, capability, aptitude etc

Skills required or beneficial to improve designing for health:

- Ability to compile a relevant pre-construction information pack
- Listening and questioning skills
- Communication – being able to get the message across, both verbally and written on drawings, reports etc

“It’s probably not something everyone does (produce an information pack) and it does scare the builders when they get loads of health and safety information, who ask why they need all that as it’s just a small project. But I think if more designers did that it would force the small builders”

(Interview, Architect)

“Ability to define issues concisely, analyse existing data/lessons learnt and communicate issues to others”

(Questionnaire, Principal Designer)

- People management – understanding the strengths and limitations of people on the project
- Being able to manage stakeholder expectations
- Ability to see the wider picture, not just the design but understanding how things are built and sequencing of work
- Innovator – ability to push for change, think outside the box and propose alternatives for discussion

“Ability to consider as many options as are available and give a reasoned decision for choice”

(Questionnaire, Contractor)

# SKATE - Knowledge

Information, facts or familiarity gained by experience or education; the practical or theoretical understanding of a subject etc

To improve the effectiveness of designing for health, design teams need knowledge of:

- CDM roles and responsibilities
- Construction processes to enable them to consider any health implications. They need knowledge about construction working methods and sequence – particularly about how materials are handled and processed on site (including simple things such as how to change the bond of a paving to avoid cutting etc ...)
- Main health risks from common construction processes

“There’s a reliance on guidance, they don’t think for themselves... I walk around hard paved areas with lots of cuts everywhere and you think the person cutting those has to bend for 8 hours... I think they know about safety because of the obvious requirements of CDM, but do they know about health, I’m not convinced”

(Interview, Client)

- Common failures that could occur so that they can be addressed at an earlier stage
- Their own and/or their team’s knowledge limitations and when to seek advice

Identified areas for improvement in knowledge:

- Increasing health awareness and understanding of human factors. This could be improved by better communication between stakeholders as it was mentioned that conversations about health may not be occurring.

“Aspects of health, whether that’s respiratory or whatever, I can’t remember ever having a conversation with anybody about what we would specify”

(Interview, Architect)

- Capturing lessons learnt and cascading knowledge sharing e.g. via email / seminars / chat rooms. This would be especially beneficial to the sole practitioner
- Improving quality, clarity and prominence of health information for products and processes

“Health aspects are often hidden in the small print and due to time constraints - you can’t read everything, so something like the kite mark would be useful”

(Interview, Architect)

- Challenging the culture of ‘cut and paste’ from previous projects without properly considering the different context of the new project

“Software is diluting professional knowledge ... younger members of the team try to find similar detail and will cut and paste from other jobs into CAD. So, learning detail from first principles is a skill that doesn’t exist anymore, we’re not designing from scratch... we’re squeezing the knowledge out of the industry”

(Workshop 2)

“Trades and industry should have responsibility to make sure health and safety knowledge learning is cascaded”

(Workshop 2)

- Knowledge sharing issues and capturing lessons learnt was raised by the majority of participants. It was believed that compiling a register of lessons learnt may not solve the problem, as issues may be too specific and people may not read the register. Problems with people moving on to other projects also reduced ability to share knowledge. The bigger the organisation, the more complex knowledge sharing becomes. Knowledge sharing tends to be more informal word of mouth. One participant claimed that the challenge of knowledge sharing would not be resolved as they said “knowledge would not be shared as: knowledge is power”.

Previous research in the construction and offshore industries found that resolving this challenge could help optimize both performance and OSH (Le et al 2014, Da Souza et al 2019).

## SKATE - Attitude

A disposition, approach, perception, reaction, viewpoint etc.

To improve the effectiveness of designing for health, design teams need an attitude that:

- is open-minded to discuss and accept challenge and adapt designs accordingly
- is willing to learn from others and appreciation that knowledge comes from a life-long learning approach
- is confident, persistent and diligent when designing

“A lot of designers insist on their vision without considering how it’s going to be realised”

(Interview, Architect)

- is willing to think beyond the traditional realm of the designer such as the aesthetics of the final building
- is observant and willing to learn from the construction phase
- is collaborative rather than confrontational
- is inquisitive about new developments, whether they are in plant, equipment or methodologies etc.
- has a sense of responsibility and ownership for the design
- has good attention to detail, unwilling to rush or cut corners

# SKATE - Training

Undergoing instruction, tuition etc.

Particular challenges regarding training:

- Problems with the design profession being unregulated in some contexts and the possibility that smaller builders may not have attended appropriate training nor hold relevant qualifications. 'Architect' is a protected title regulated by the Architects Registration Board, but anyone can call themselves an 'architectural designer' or offer 'architectural services' and many people do not know the difference

"The biggest problem in the UK is that people watch Grand Designs and suddenly become a designer ... the industry has a massive weakness in that there's a large part of the work in the UK, at a small level, done by people who have zero training in health and safety"

(Interview, Architect)

- Increase in 'teach yourself design' IT packages

"People setting themselves up at home with some software and calling themselves 'Architectural Services', but they are not qualified"

(Interview, Architect)

- Inadequate coverage of designing for OSH in Universities. During research by Behm et al (2014) they found that, by incorporating reference to the hierarchy of controls for OSH and design thinking into additional courses and textbooks, the concept became more integrated, resulting in a greater and earlier awareness of design responsibility for hazard and risk mitigation.

"One of the graduates asked me "what is CDM?" and I was thinking I can't believe you don't know"

(Workshop 1)

- Poor content in design for OSH continuing professional development (CPD) requirement training

"Under RIBA you [just] end up sitting in another talk about CDM regulations and I think the variety of training available is limited"

(Interview, Architect)

"[We need] more training. If you train people and they are aware of what issues to look for, it then becomes common design practice"

(Workshop 1)

To improve the effectiveness of training for designing for health, participants suggested that industry and organisations need to:

- improve awareness and basic training of occupational health, human ergonomics, or wider aspects of human factors and include them in mentoring sessions and on all relevant courses (some suggested relevant IOSH or NEBOSH courses)
- ensure such courses do more than just provide information on the CDM regulations
- provide on-site / on the job training
- consider apprenticeships which emphasise practical aspects rather than just academic knowledge
- demonstrate ongoing learning, for example:
  - a. CPD should include specific hours spent on health
  - b. Instigate mandatory OSH training hours per year
  - c. Organise and require attendance at seminars (to include lessons learnt, new legislation etc)

## SKATE - Experience

Involvement / participation in a given subject; actual observation or practical acquaintance with facts or events, with knowledge and/or skills resulting from this

Lack of site experience was a concern raised by participants. These quotes are representative of many participants' comments:

"I have concerns that younger architects will not have site experience ... we get planning permission, but then someone else builds it and we're not involved, never get to site so how can you show a trainee how to do it if the job doesn't exist anymore"

(Interview, Architect)

"It's about getting that experience, getting out onto site and being put in the position where you're dealing with professionals and learning from others"

(Workshop 3)

"Designers need hands on experience ('feel' the environment), to understand different working conditions (weather, time of day/year, space constraints, budget & deadline pressures and how they can impact on attitude/behaviour"

(Questionnaire, Principal Designer)

"Site experience – there is no substitute for seeing construction in action. Incidents/accidents focus the mind and make you appreciate the reality of what you have designed"

(Workshop 1)

To address concerns, it is suggested that industry and organisations should:

Facilitate and require ongoing site experience, especially important for those newer to the role

- Lobby the professional institutions to require a mandatory site placement period for designers before they become chartered / fully qualified
- Assign senior/experienced designers as mentors for younger staff

# Conclusions

Fundamentally, designing for occupational health faces the same challenges that still exist in designing for safety – but much worse! There is a need for a move towards ‘managing health like safety’. It would appear that clients, designers, contractors and other stakeholders, even the experienced ones, do not fully understand occupational health, meaning that Design for Health is already at a disadvantage.

Establishing SKATE expectations for Designing for Health is a complex task and is likely to take time to fully understand and develop robust guidelines.

SKATE as an acronym was useful as it helped focus people on specific attributes and thinking deeper about requirements. However, understanding what attributes designers require in order to be able to Design for Health is not the only issue.

Organisations and industry need to raise awareness that health is just as important as safety, rather than seen as an ‘optional extra’. There is much less information and guidance on Designing for Health compared to Designing for Safety. There is regular information and hence awareness about safety issues and it is easier to understand safety as the consequences are more immediate, however there needs to be a greater focus on health and the consequences. Currently there is industry-wide emphasis on mental health which, unintentionally, may be reducing the focus on other important occupational health challenges.

There is a wealth of design knowledge in parts of the construction industry, but how much is captured (lessons learned) and passed on to others is unclear. Knowledge gained from projects should be captured by industry and circulated as ‘lessons learnt’ for all to use in future projects. There are clearly challenges due to the varied nature of the industry (sole trader to large organisations), fragmentation and geographical spread of the work of designers. Even within one organisation lessons learned may reside in different locations. This captured knowledge would aid designers in meeting the requirements of general principles of prevention and what is classified as ‘reasonable’ by taking into account current industry knowledge and practice. Resolving this challenge will bring benefits, not only of increased Design for Health knowledge, improvements to the health of construction workers and end users, but also financial benefits.

Perhaps greater use of the USA term, Prevention through Design, rather than the terms usually used in the UK (Designing for Safety, Designing for Health) may promote consideration of occupational health hazards affecting construction workers when design decisions are contemplated, rather than considering Design for Health related more to the end user.

# Design for Health SKATE Key Recommendations

- CDM has SKE, but it is suggested CDM should also include T, Training.
- This should help with the problems of the design profession being unregulated and the possibility that smaller builders may not have attended adequate training or hold relevant qualifications.
- It is suggested that industry / organisations consider how young / less experienced designers can increase time spent on construction sites.
- Young / less experienced designers do not have enough experience of working on a construction site to develop their knowledge of health hazards, how design can mitigate them and how their designs are built.
- While many undergo CPD, it is suggested that ongoing development would be useful for all designers, to include a specific number of hours spent on health. During discussions newer qualified designers had a better understanding of the concept of health risk. Currently, CPD courses include health and safety sessions, but the topics can vary - there is a need to split out health from safety and be clear on yearly hours required for each. Perhaps this could be included within CDM training.
- There needs to be an increased focus of health as a topic included within training courses, standards and audits. Comments suggest that safety aspects are considered, but health issues probably not as "it's not occurred to anyone".
- Industry needs to help Designers understand the level of residual risk detail to be provided and that Designers should not assume that contractors will know what the risks will be without being told. If designers consider health risk at the design stage, there should then be less reliance on the contractor to mitigate risk. This research finding also raises an important point about how designers determine the competence of contractors and thus what 'unusual or significant' risk information they would provide. This requires further discussion to understand how designers assess contractors' competence with regards to how much/how little detail they need to provide, especially as there is variation in capability between contractors. For the time being, should designers be advised to assume that contractors are not aware of occupational health issues and therefore be more diligent in identifying residual health hazards than they would be for safety hazards?
- A health checklist may be useful as an aid memoir. Perhaps, industry could compile and circulate a checklist for organisations to adapt for their own use. This could include hazards, risks, solutions
- A tool could be developed to help organisations capture and share knowledge. There was a lack of 'knowledge' in how to mitigate risks of harm to health in design. Organisations recognised the importance of knowledge sharing, including lessons learned, but acknowledged that this is an area where there is room for improvement. Perhaps industry could develop a tool for capturing knowledge in one location and sharing to everyone (this could include a knowledge library, guidance and an ability to ask an expert)
- Greater use of the USA term 'Prevention through Design' – The term 'Design for Health' may be confusing. Introducing the term 'Prevention through Design' may increase the chance that occupational health is integrated at source when design decisions are contemplated for the construction phase, rather than considering the limited scope of Design for Health related more to the end user.

## Further research

Comments suggest that 'external parties' may be attracting the duties of Designer, this requires further research.

Clients need greater awareness of health issues and their responsibilities for OSH during the construction phase, how could this be achieved?

## References

- Baxendale T, Jones O, 2000. Construction design and management safety regulations in practice - progress on implementation. *International Journal of Project Management*, 18, 33-40
- Behm M, Culvenor J, Dixon G, 2014. Development of safe design thinking among engineering students. *Safety Science* 63, 1-7
- Da Souza C, Broberga O, Paravizob E, Jensen A, 2019. A four-step model for diagnosing knowledge transfer challenges from operations into engineering design. *International Journal of Industrial Ergonomics*, 69, 163-172
- De Souza J, 2003. Designing for health and safety. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability*, 156 (2), 125-126
- Gambatese J, Behm M, Rajendran S, 2008. Design's role in construction accident causality and prevention: Perspectives from an expert panel. *Safety Science*, 46, 675-691
- HSE, 2018. Construction statistics in Great Britain, 2018. <http://www.hse.gov.uk/statistics/industry/construction.pdf>
- HSE, 2019. Designers: roles and responsibilities. Construction (Design and Management) Regulations 2015 (CDM 2015) <http://www.hse.gov.uk/construction/cdm/2015/designers.htm>
- Horne K, Gibb A, Pavitt T, Haslam R, 2003. D4h: influences on designing for health: results from interviews and questionnaires. In: Greenwood, D J (Ed.), 19th Annual ARCOM Conference, 3-5 September 2003, University of Brighton. *Association of Researchers in Construction Management*, 1, 101-10
- Karakhan A, Gambatese J, Alomari K, Liu D, 2018. Consideration of worker safety in the design process: A statistical-based approach using analysis of variance (ANOVA). *Construction Research Congress 2018: Safety and Disaster Management - Selected Papers from the Construction Research Congress*, 378-388
- Le T, Lee D, Park C, 2014. A social network system for sharing construction safety and health knowledge. *Automation in Construction*, 46, 30-37
- Lingard H, Cooke T, Blismas N, 2012. Designing for construction workers' occupational health and safety: a case study of socio-material complexity. *Construction Management and Economics*, 30, 367-382
- Miang Y, Chua S, 2016. Knowledge, attitude and practices for design for safety: A study on civil & structural engineers. *Accident Analysis and Prevention*, 93, 260-266
- Smallwood J, 2015. Designing for Construction Ergonomics. *Procedia Manufacturing*, 3, 6400 - 6407
- Toole M, Gambatese J, Abowitz D, 2017. Owners' Role in Facilitating Prevention through Design. *Journal of Professional Issues In Engineering Education and Practice*, 143 (1), 1-9
- Weinstein M, Gambatese J, Hecker S, 2005. Can Design Improve Construction Safety?: Assessing the Impact of a Collaborative Safety-in-Design Process. *Journal of Construction Engineering and Management*, October, 1125-1134

