

MAGIC

MArginal Gains In Construction:
UK industry strategy to deliver more Value with less Cost

DRAFT FOR DISCUSSION: JULY, 2016
CHRIS WISE AND ED McCANN: EXPEDITION ENGINEERING, LONDON

AIMS OF THIS PAPER

1: TO RAISE AWARENESS AND ENGENDER SUPPORT

To stimulate interest

To raise awareness

To gain personal, institutional and governmental support and endorsement for these efforts.

2: COST: BENEFIT ALIGNMENT WITH THE AIMS OF STRATEGIC BODIES

To establish alignment with strategic bodies such as the National Infrastructure Commission, which is tasked as follows:

“The National Infrastructure Commission will enable long term strategic decision making to build effective and efficient infrastructure for the UK and will be established by legislation as an independent body.”

Key words for us are “effective and efficient...”

Effective is the NIC’s way of saying “value”...ie it gives the user what they need reliably and well.

3: ADVICE ON EFFECTIVE DEVELOPMENT

To seek strategic advice on how we might proceed to develop and deliver some of the initiatives that we are proposing.

4: IDENTIFICATION OF FUNDING PARTNERS

To identify possible sources of practical R&D funding, and potential cross-industry funding partners.

This funding would be used to develop practical measures to take advantage of the cost reduction opportunities across the industry.

BACKGROUND



We have been looking at efficiency and effectiveness in construction for many years.

This paper draws together some of those strands, summarising how a strategy of many marginal gains can have a significant and beneficial impact on the cost of new UK construction. Compared to many industries, construction has a market dis-function in R&D. We believe that the lack of vertical integration is the single biggest problem and is notably different from other industrial sectors.

In effect:

Motivation for innovation is low (due to construction's high turnover/low margin business model)

Those investing in innovation struggle to get it adopted (lack of control)

Those investing in innovation rarely benefit fully from the value generated (inappropriate business model).

Latham, Egan and others tried to deal with this by building contractual relationships that allow value to be generated and shared but with limited success and occasionally unintended negative consequences. Perhaps the Big Restructure can in the end work for Major Infrastructure organisations but much of the construction sector is not and will not be like that.

Our involvement began 25 years ago with the first practical office loading study with Arup, for Stanhope (for Peter Rogers and Sturat Lipton), showing incremental reductions in construction costs using realistic loads in lieu of default letting

market practice.

In 2010, Expedition's *Enough is Enough* presented the case for lean engineering of everyday structures through Chris Wise's IABSE Milne Medal Keynote; the Winton Symposium keynote at Cambridge University (funded by Winton Capital's David Harding), and Wise's column at Building magazine.

Enough is Enough (now updated from carbon savings to include ££'s savings) shows how lean engineering can save £5 Billion per year in new structures. With allied trades, this increases to a potential saving to UK construction of over £10 Billion per year.

Enough is Enough thinking was recognised by senior industry figures including Peter Hansford, formerly Chief Construction Advisor, and later supported by published work by Cambridge University.

In 2015/16, Ed McCann and Tom Barton (formerly Sir Robert McAlpine) developed and ran the ICE's *Get it Right Initiative* into the costs and causes of error in construction. A group of 15 major contractors and clients funded the study. *Get it Right* identified where, in a practical way, reduction of construction errors would save up to £20 Billion per year in the UK.

Get it Right creates a set of reasoned propositions designed to "make construction better through practical action", involving clients, contractors, designers, researchers and end users.

Taken together, the work shows how to save 25% to 33% of the UK's new construction costs every year.

ENOUGH IS ENOUGH SHOWS HOW LEAN ENGINEERING WOULD SAVE AT LEAST £5 BILLION PER YEAR IN NEW STRUCTURES ALONE, WITH SIMILAR SAVINGS POTENTIAL IN OTHER DISCIPLINES.

GET IT RIGHT IDENTIFIES PRACTICAL WAYS IN WHICH THE REDUCTION OF COMMON CONSTRUCTION ERRORS WOULD SAVE UP TO £20 BILLION PER YEAR IN THE UK.

TAKEN TOGETHER, THESE TWO STUDIES SHOW IN A PRACTICAL WAY HOW TO SAVE FROM 25% TO 35% OF UK NEW CONSTRUCTION COSTS EVERY YEAR, REDUCING NEW BUILD COSTS BY £20 TO £30 BILLION.

FRAMING THE PROBLEM

We have been talking about endemic quality and productivity problems in Construction for many years.

In a functioning market we would expect efficiency and effectiveness to be progressively improved through competitive processes, Adam Smith style, ie.....:

*More productive digger =>
competitive advantage =>
leads to new generation of diggers=>
adopted across the sector
and so on.*

It is clear that simple market / evolutionary forces are not working well in the construction industry.

Our analysis of the root causes for these deep-seated problems mirrors that of many.....:

**IT IS CLEAR THAT
SIMPLE MARKET /
EVOLUTIONARY FORCES
ARE NOT WORKING
WELL.**

| Institutional and Habitual | Economic | Technical and Performance-related | Knowledge and Perceptions |
|---|--|--|--|
| Additional design work impacts on delivery time and cost | Insufficient comparative information on costs | Lack of confidence in contractor ability and availability of skilled labour prevents inclusion in design | Lack of awareness and practical knowledge of alternatives amongst practitioners |
| Design inconvenience: more detailing; more drawings more cost | Money sunk in existing materials, technologies and practices (in terms of training, establishing relations with supply chains, etc.) | Lack of full-scale demonstration projects | Lack of client knowledge of alternatives |
| Focussed training and recruitment results in departmental lock in to familiar materials, technologies and practices | Small industries producing alternatives cannot compete against established industries' economies of scale | Insufficient fit with the culture of the clients/inhabitants | Negative perceptions amongst practitioners based on past experiences |
| Habitual specification and historic practice of individual practitioners | Anticipated increase in lead times | Insufficiently developed supply chains | Negative perceptions of the new approach held by clients |
| Lack of effective marketing from producers limits awareness | High (expected) cost of novel approaches | Issue addressed by the approach is regarded as low priority and other considerations take precedence | Shortage of specialist skills prevents proper execution of innovative approaches |
| Lack of user-producer relationships | High transaction costs of additional professional training and research | Lack of established standards, design guides and tools, and standardised details | |
| Recruitment and training reinforces dominant technologies & practices | Maximising repeat processes to minimise cost mitigates against new processes | Lack of performance data | |
| Uncoordinated marketing and advocacy efforts for novel technologies & practices | No external pressure to address the issues at hand | Local availability of materials, technologies and practices and technologies | |
| Viewed as outwith responsibility or remit of any individual | Project financing incompatible with time constraints | Perceived concerns about sourcing prevents selection | |
| Widespread influence of dominant approaches to production | Uncertainty premium placed on novel options, just in case | Perceived unreliability or risk of new alternatives | |
| | Unwillingness to accept risk | Policy and regulatory limitations and restrictions - not driving the needed change | |
| | Policy uncertainty restricts investment | | |

SOLUTION STRATEGY USING MARGINAL GAINS

The dominant strategy that has been promoted since Egan is whole market reform.....restructuring relationships from top to bottom, vertical integration and so on. Some continue down this line. The jury is out on whether this can succeed given the highly evolved, and high inertia nature of the industry.

Many that we speak to invested time and effort in the initiatives that flowed from the Egan report and are frustrated/jaded by what they perceive to be a lack of substantial impact.... All of the issues around low margins, low productivity, poor image persist....

From our experience delivering innovation in business and on projects, we have a different approach which is based on targeted "small" changes which are manageable but deliver substantial benefits in short timeframes.

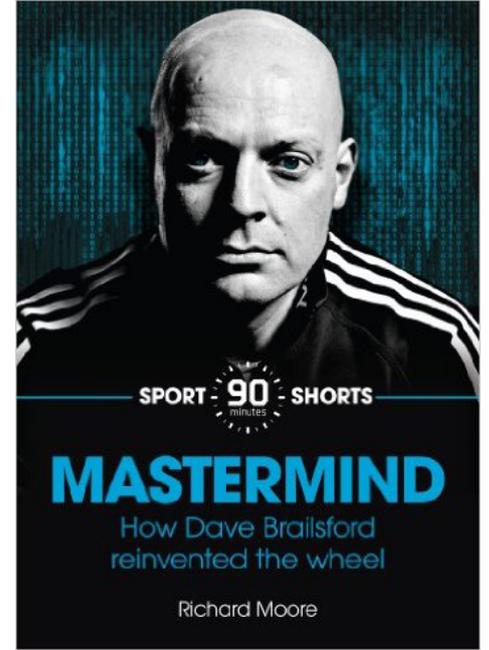
The advantage of this approach is that corporate inertia is easier to shift in smaller packages, and success can be seen sooner (encouraging a willingness to consider more change)

With this approach we try to find specific interventions that would generate notable efficiencies in their own right. In designing and implementing the solutions we need to understand and address the complex nature of the industry or the solution will not work....

This approach depends on effective collaborations and sets out to establish value chains where the "person" paying derives some direct benefit in a reasonable timeframe....

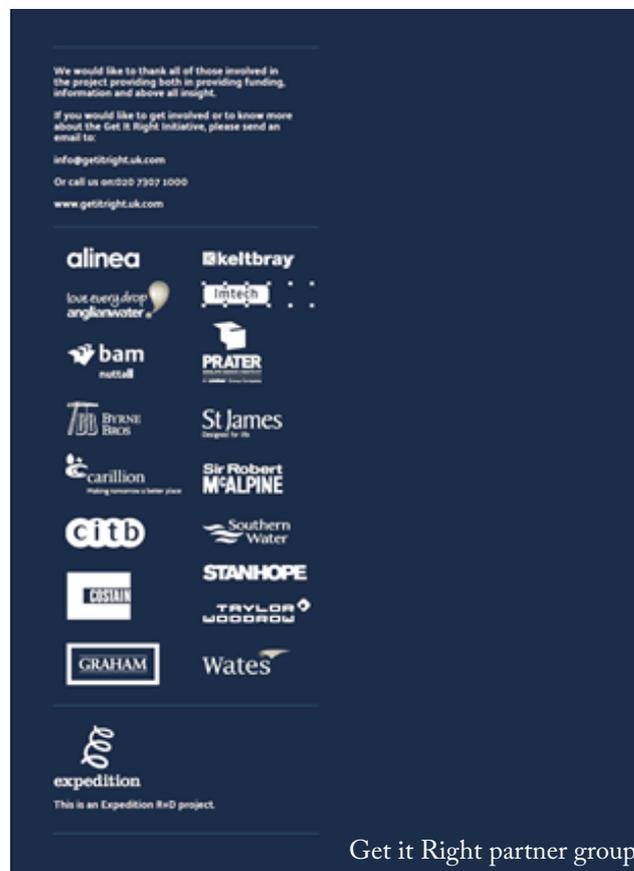
This is analogous to David Brailsford and cumulative marginal gains in cycling.

But instead of a few seconds around a track, taken across the construction industry each "marginal gain" would potentially generate annual savings measured not in seconds but in hundreds of millions or sometimes billions of pounds to UK businesses and clients.



TAKEN ACROSS THE CONSTRUCTION
INDUSTRY, EACH MARGINAL GAIN
MIGHT GENERATE ANNUAL SAVINGS
MEASURED IN HUNDREDS OF
MILLIONS,
OR SOMETIMES
BILLIONS OF POUNDS.

SOLUTION EXAMPLE 1: GET IT RIGHT INITIATIVE. IMPROVED VALUE AND LOWER COST BY ELIMINATING ERROR



Chaired by Expedition's Ed McCann, *Get it Right* is an industry-led research project which identified £15 to £20 billion/year cost to UK construction associated with avoidable error. The research also identified the root causes of this error.

The research showed how groups of clients and contractors working together, rather than in competition, could pursue efficiency through collaborative cross-industry R&D. Collaboration provides a basis to share costs and expertise between them but all benefit from the results. This improves their business models, and that of the UK construction industry as a result.

Four strategic threads were found to progressively reduce cost.

As an example:
One thread focuses on skills. In the initial stages three activities have been developed to start to address the skills problems of:

- Construction Design Managers;
- Site Supervisors
- and Trade Operatives respectively.

With the group of 10 major contractors and the CITB, and using a collaborative funding model *Get it Right* developed a training proposal for Construction Design Managers that would deliver high impact at a cost well below what an individual organisation could otherwise achieve.

In this case, participants each get a training product tailored to address a real need in their business to improve current challenges around poorly co-ordinated and communicated design information. By co-designing the training, each gets a £100k training product for £5k.

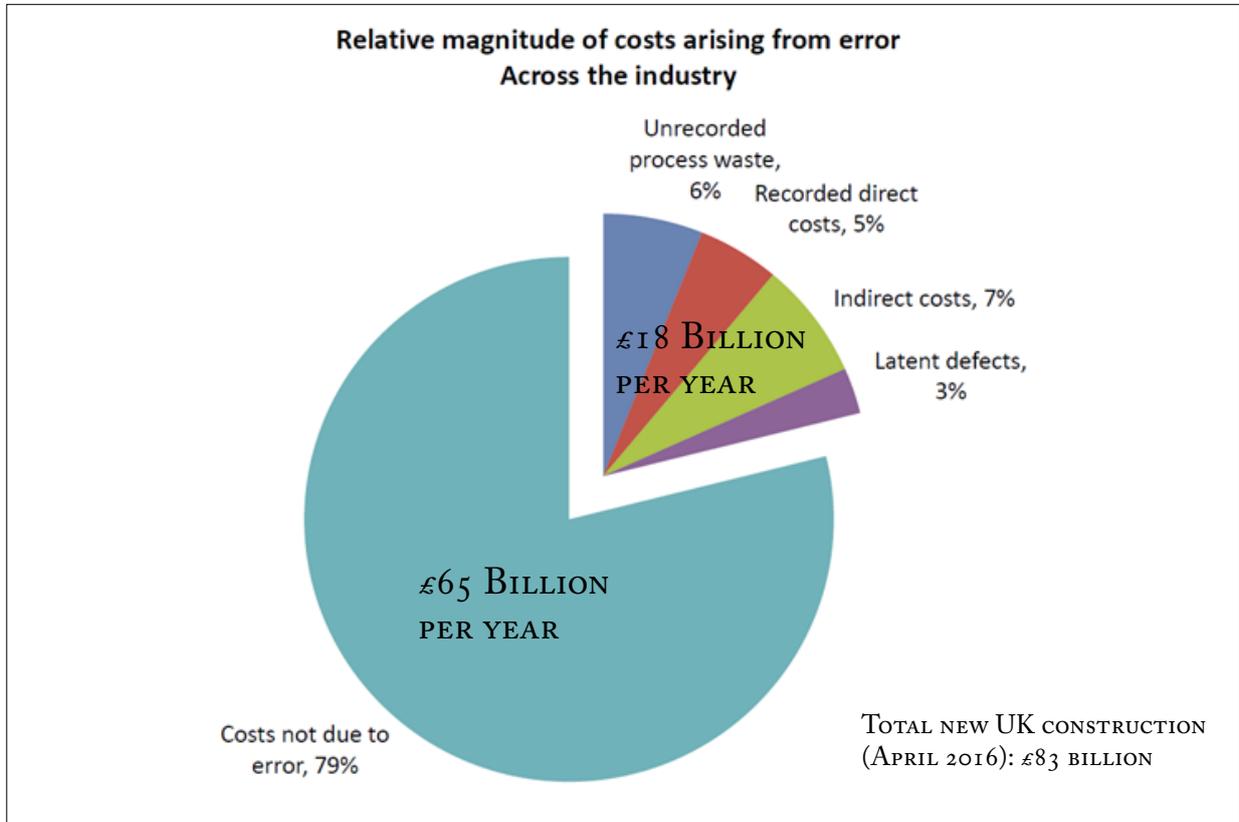
Through such skills training and value propositions we can do useful things which in the aggregate lead to major improvements in efficiency and effectiveness.

GET IT RIGHT:
THE INDUSTRY-LED
RESEARCH PROJECT
IDENTIFIED THE ROOT
CAUSES OF
£15 TO £20 BILLION/
YEAR COSTS TO UK
CONSTRUCTION
ASSOCIATED WITH
AVOIDABLE ERROR.

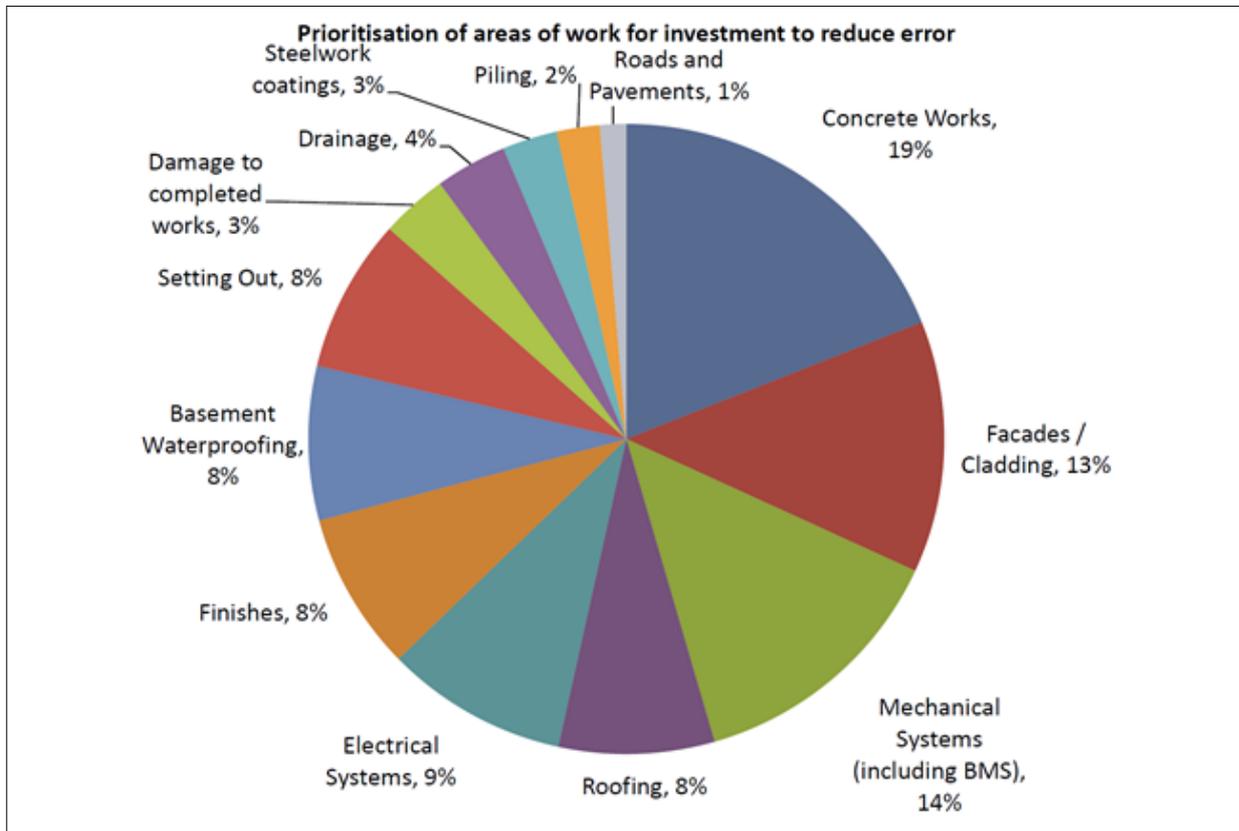
GET IT RIGHT REPORT:

21% OF COSTS ARE DUE TO ERRORS:

£18 BILLION/YEAR IN UK (NEW CONSTRUCTION)



Data from "Get It Right" (2016)



Data from "Get It Right" (2016)

SOLUTION EXAMPLE 2: ENOUGH IS ENOUGH.

IMPROVED VALUE AND LOWER COST THROUGH LEAN ENGINEERING

In 2010, Chris Wise used his Milne medal address at IABSE in London to deliver a proposition on the significance of marginal gains in the structural engineering profession, called *Enough is Enough*.

Attended by many senior players in the industry, the proposition looked at improvements to materials performance and impediments to adoption, and was met with statements such as "Of course...why on earth aren't we doing that?"

Originally described in terms of carbon reductions, the study has now been updated to include the key metrics of Cost Savings.

Enough is Enough looked, for example, at improvements to the humble I-Beam:

Patented in 1849, there has been virtually no change in the sectional characteristics of the ubiquitous I-beam....

It turns out that by varying the flange thickness we can save 30% of the beam steel....

If only there was a machine that could vary the flange thickness....

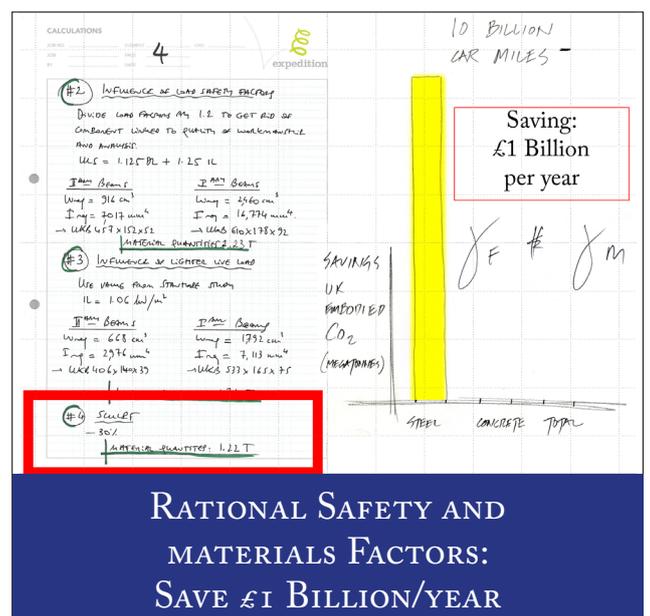
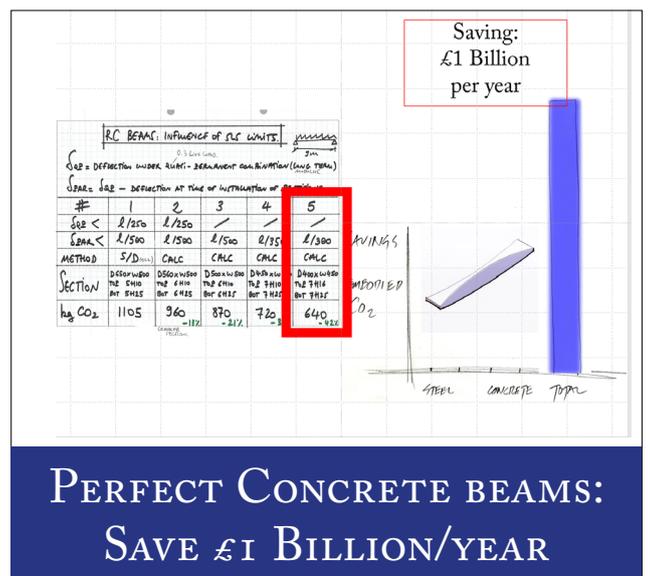
There is...it is made by Siemens.

So why don't we design the flange thickness to vary....?

Well structural analysis might become more complex, and variable section steel mills would have to be built for the purpose at an initial investment of £25m to £40m (according to Siemens). But such a plant would be a world leader.

And we would progressively chase a 20-30% reduction in the UK's steel costs.... saving ££ hundreds of millions a year to say nothing of carbon, and material waste.

Incidentally, if we don't do this, the Chinese will.....(David Harding, CEO Winton Capital Group was on the phone to his Chinese partners during one of Wise's lectures on the subject at Cambridge University)



ENOUGH IS ENOUGH....AND BEYOND.....

The findings of Enough is Enough were given strong academic support when, in 2013, Professor Julian Allwood of Cambridge University published a research paper on the subject at the Royal Society.

Jonathan Cullen of Professor Allwood's research team had attended the initial *Enough is Enough* lecture at IABSE.



Transitions to material efficiency in the UK steel economy

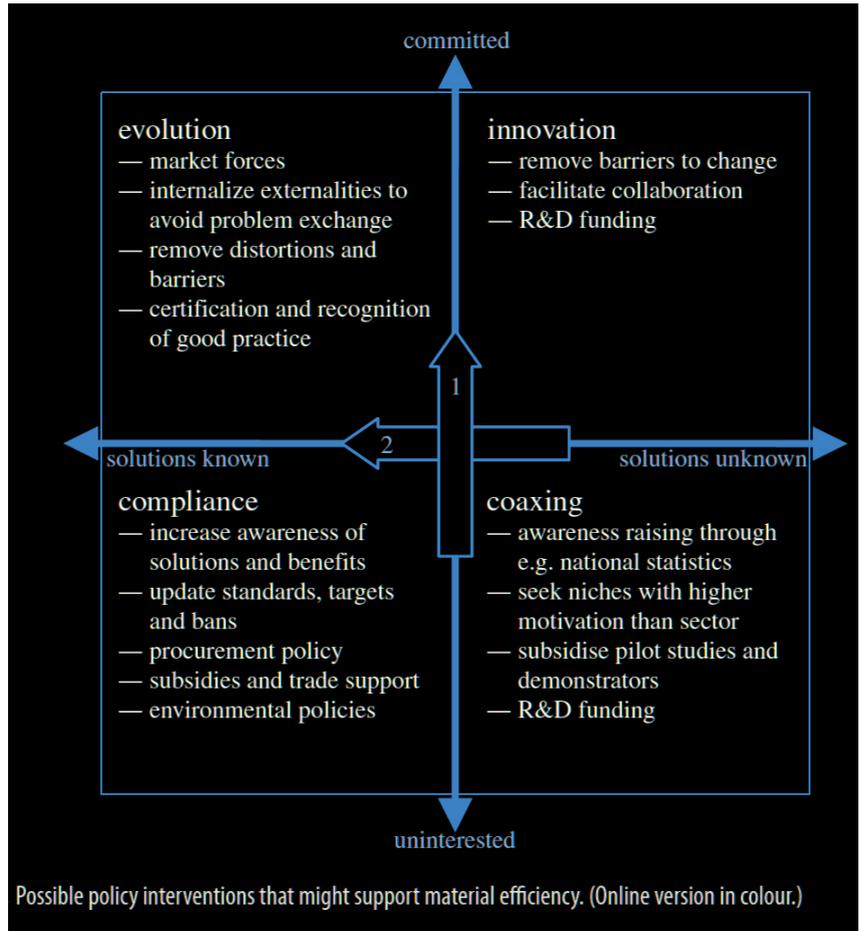
Julian M. Allwood

Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, UK

Figure 7 of Allwood's paper maps potential policy interventions to support material efficiency (reproduced at right).

The Figure shows that Evolution (upper left) needs policy intervention even if solutions are known and parties committed.

Enough is Enough focusses attention also on Innovation, Compliance and Coaxing to achieve greater cost reductions, but the market has not so far moved this way on its own, unprompted and uninterested. To change this motivation is the challenge.



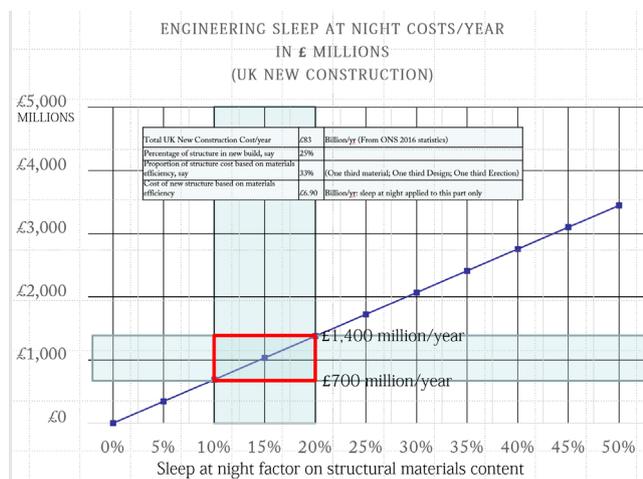
Possible policy interventions that might support material efficiency. (Online version in colour.)

In 2015, McCann and Wise met the then Chief Construction Advisor Peter Hansford to discuss how to respond to the Government's 2025 Construction Strategy targets.

Among the subjects under discussion was "habitual over-design"; the expedient and endemic practice of adding "a little bit of extra" to a structure just to sleep at night.

The cost of this practice has now been quantified at between £700 million and £1.4 billion per year in structures alone.

This cost could be eliminated by adding the simple phrase "...AND NO MORE" into design codes and procurement documents.



THE SIMPLE ACT OF ADDING THE WORDS "...AND NO MORE" INTO DESIGN CODES WOULD SAVE ABOUT £1.4 BILLION/YEAR

NOTE 2B Partial factors γ_{M} for buildings may be defined in the National Annex. The following numerical values are recommended for buildings:

- $\gamma_{M0} = 1.00$
- $\gamma_{M1} = 1.00$
- $\gamma_{M2} = 1.25$

6.2 Resistance of cross-sections

.....AND NO MORE

6.2.1 General

(EN) (1)P The design value of an action effect in each cross section shall not exceed the corresponding design resistance and if several action effects act simultaneously the combined effect shall not exceed the resistance for that combination. (EN)

- Shear lag effects and local buckling effects should be included by an effective width according to EN 1993-1-5. Shear buckling effects should also be considered according to EN 1993-1-5.
- The design values of resistance should depend on the classification of the cross-section.
- Elastic verification according to the elastic resistance may be carried out for all cross sectional classes provided the effective cross sectional properties are used for the verification of class 4 cross sections.
- For the elastic verification the following yield criterion for a critical point of the cross section may be used unless other interaction formulae apply, see 6.2.8 to 6.2.10.

PROPOSAL I: ESTABLISH AND EMPOWER A CROSS-INDUSTRY GROUP TO IDENTIFY AND ELIMINATE INEFFICIENCY

We believe that there would be great value to establishing a cross industry group charged with finding inefficiencies and then developing and implementing initiatives to overcome them.

The work of this group would be deliberately pragmatic and focus on benefits in the short to medium term.

The means of generating change would be through initiatives to change behaviour, rather than major structural reform of the whole construction sector Egan-style.

To start, we recommend producing a list of the top ten un-adopted innovations in the sector by impact and then developing initiatives to get them adopted.

For example: BAM Nuttall's Steve Fox is convinced that self-compacting concrete should be standard and that if we used it we would eliminate most of the problems that we currently have with over and under-compaction.

He believes that if people priced in the realistic cost of "sorting out the problems" with traditional concrete that self-compacting concrete would be cost beneficial.....but traditional costing methods delude themselves by pricing conventional concrete on the basis of a perfect job.

The group could explore this in detail and if Steve is right, produce a compelling argument to convince clients and specifiers to change their specification.

For example, widespread adoption of self-compacting concrete would then generate economies of scale as well as new technologies in delivery and formwork to

further reduce the cost....say.

This group might also be tasked with developing an R&D agenda which addresses current inefficiency as well as the exciting hi-tech future currently promoted by Innovate UK and EPSRC.....the idea would be that by explaining clearly the financial and service benefits of improving efficiency governmental funding agencies would put some money into that too.

Not sexy but worthwhile nonetheless.



Self compacting concrete was good enough for the Akashi Kaikyo Suspension Bridge

...ESTABLISH A CROSS-INDUSTRY PROGRAM TO FIND THE TOP 10 UNADOPTED INNOVATIONS IN THE CONSTRUCTION INDUSTRY, AND GET THEM ADOPTED (eg SELF-COMPACTING CONCRETE)

PROPOSAL 2: ESTABLISH INDUSTRY-LED R&D CENTRES FOR PRACTICAL CONSTRUCTION.

Our analysis of academically-driven R&D in our sector has revealed a number of deficiencies. Many have identified the mismatch between the academic R&D activity and the current needs of industry.

We believe that until we are able to get industry in a position to set the construction R&D agenda we will make little progress.

Additionally, we observe that in the construction sector (unlike automotive, aviation and others) our “trained inventors” (ie the design professionals and some of the specialist trade designers) are more or less precluded from “doing invention” by virtue of the single-project-at-a-time business models within which they operate.

We would look to involve “pro-designers” in a paid capacity on collaborative R&D within these sectors.

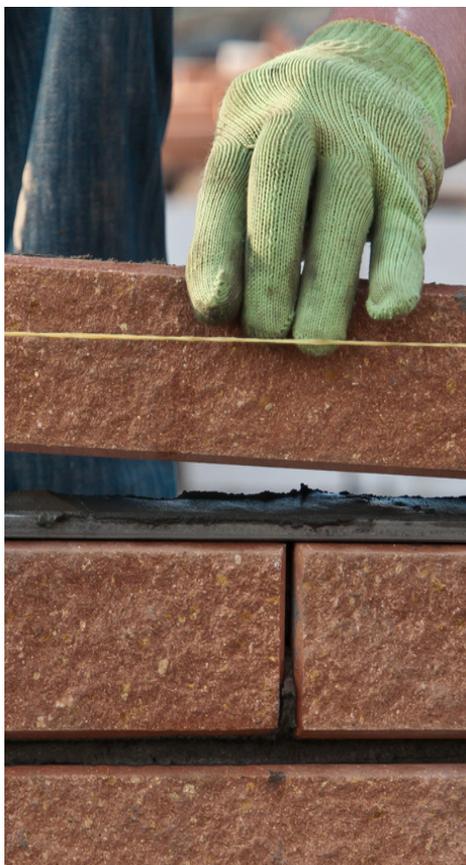
Examples of the sort of thing that we might have a go at in these centres for practically-oriented construction-industry research would be:

- the National Pot-hole Challenge
- the Integrated Service Trench system
- the Perfect Slab/beam/wall
- the Perfect concrete spacer and
- the Really-well-built brick wall

This last example would be used to show how to reduce the overall Factor of Safety on masonry construction from 3.5 to less than 2.5. This would recognise that the code’s descriptions of “*special construction*” and “*special materials*” are readily achievable in everyday C21st practice.

For funding, we would consider models including conventional research and innovations streams, but these have to date not delivered the results the industry needs.

Therefore, in addition, we propose alternative crowd-source/membership fundings streams from industrial, client, government and research bodies who stand to benefit, as summarised in *Get it Right*.



Prototype to prove a really well built wall reduces waste from excessive safety factors

DEVELOP “*GET IT RIGHT*”,
AND “*ENOUGH IS ENOUGH*”,
INTO PRACTICAL R&D
PROGRAMS AIMED AT
PROGRESSIVE, BUT RAPID
IMPLEMENTATION, THROUGH
EXTENSIVE PROTOTYPING