



# Design for Deconstruction

(D4D)

Feasibility Study October 2014



# 1.0 Executive Summary

Constructing Excellence in Wales (CEW) played a principal role in the development of the Construction and Demolition Sector Plan (C&D SP) (November 2012).

CEW facilitated valuable consultation with a variety of stakeholders which helped to identify the preferred direction the sector would take to meet the targets outlined in Towards Zero Waste. The C&D SP required CEW to raise awareness of the importance of designing for end of life and recommended that designers, architects and construction companies utilise existing practice to assist in meeting these targets. This led to CEW working with industry to promote the consideration of the deconstruction and demolition of a building at both the design and construction stages. This should include evaluation of the techniques and materials that could be employed which, in the long term, would facilitate extraction and reuse. This approach is termed 'Design for Deconstruction (D4D)'. The overarching objective of the study is to examine the feasibility of D4D methods in construction practice. Is this an initiative that can be applied to the industry? If so, what are the most manageable, cost effective and environmentally friendly methods? The study attempts to answer these questions and provide guidance raising the profile of D4D. The feasibility study aims to ascertain the importance of the D4D principle to the

construction industry and the value it can bring to the built and natural environment. The study analyses existing practice, barriers and opportunities and makes recommendations for the implementation of D4D.

Survey and workshop exercises were undertaken with key stakeholders from the industry in Wales to elicit valued feedback from construction representatives. The survey responses provided an understanding of the general consensus within the industry in relation to D4D and led to an in-depth workshop with professionals in their respective fields.

Both research and industry responses highlighted that the main reasons for continued interest and application of D4D stemmed from the possibility of carbon emission reductions, minimisation of resource extraction and a reduction in landfill waste. These would all result in sizeable cost and carbon savings. Constraints surrounding the implementation of D4D were highlighted and include the limited availability of reusable materials, no certainty of improved performance by using reused materials and a lack of legislation or incentives.

The open nature of the workshop raised a number of issues concerning the feasibility of D4D. Economic, environmental and social constraints and opportunities were identified. For this reason, it seemed appropriate to focus the report upon the sustainable development model.

Social and economic drivers that could help to implement D4D include the introduction of tax incentives, carbon credits, training courses and upskilling regimes. The use of funding conditions stipulating the application of D4D within projects was also identified to be a potential mechanism for implementation. Environmental drivers include the quantification of energy and carbon savings through reducing CO<sub>2</sub> and conserving natural resources.

Recommendations that have resulted from the study will be put forward to Welsh Government.

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# Introduction

## Terms of Reference

Design for Deconstruction (D4D) was an overarching action in the Welsh Government Construction and Demolition Sector Plan (November 2012). Constructing Excellence in Wales (CEW) was tasked with conducting a study to address existing practice, constraints and opportunities resulting in a list of recommendations for Welsh Government. The following grant memorandum was agreed:

### Grant Memorandum requirements;

- Preparation of a feasibility study to examine the opportunities for using the planning system to increase the recovery of a building at the end of its life
- Development of a plan to implement planning for deconstruction into planning conditions (on positive outcome of feasibility)
- Develop guidance/template for recovery plans for demolition and refurbishment projects
- Focused events/materials for designers/architects/planners outlining the principles of D4D

Having due regard to our obligations outlined above, the first step in the process was to consult with a senior representative from Welsh Government Planning. As a result of this consultation, it was immediately apparent that implementation through the planning process would be extremely difficult, not least because planning powers predominantly cover land use rather than construction thereon.

Consequently, whilst not excluding planning entirely from the process, the study has focused more on design and building standards.

## Context

Despite a recent upturn in fortunes across the construction industry there are still a number of issues that are hampering development and sustainable success for many companies and the wider professions and industry. Some of these issues include dwindling natural resources, climate change impact, increasing CO<sub>2</sub> emissions and the need for more effective waste minimisation and reduction. Designing for deconstruction could be an important contributor to reducing and combating these evolving issues.

Design for deconstruction is a principle that has been around for many years but it is still not fully implemented in industry. This study explores and analyses the D4D principle and highlights opportunities that could be exploited or implemented in construction practice. The study aims to raise awareness across the industry sectors whilst outlining recommendations. We are mindful of excessive regulation and intend to maintain the feasible element to the study. Sustainable development is a legal requirement throughout Wales and this project will look at applying an advantageous sustainable impact on new or existing construction projects. It will aim to help reduce the industry's ecological footprint by increasing the recovery of materials and promoting landfill diversion.

In Wales, the construction industry generates over 12 million tonnes of waste per annum. The waste policies and targets are set out in 'Towards Zero Waste'. One Wales One Planet also aims to create a more sustainable Wales through waste minimisation and reducing our ecological footprint. We want to plan for less waste and better building design is one way of achieving this goal.

## Aim of the project

The aim of the project is to manage end of life building materials to minimise waste in construction and maximise the potential of a building to become a resource of great value at the end of its life. This study seeks to create scope for planning, building control and/or waste management to support effective deconstruction.

## Format of the report

The report starts with a brief introduction addressing the context and project aim in relation to grant requirements and desired study objectives. This sets out the direction of the study and the reasons behind the chosen subject. The second section comprises the methodology and processes undertaken including research, survey work and workshop exercises. This leads onto the key findings and observations drawn from topic research and interactive exercises with industry. All of which contribute to the recommendations of the study.

# Methodology

It was established from the outset that the project would be aligned with the sustainable development model focussing on economic, social and environmental criteria.

There have been several stages to the study ranging from extensive research to open industry workshops. The sustainability theme has been maintained throughout the process.

## Research

Once the project objectives had been set and the scope had been agreed, the next step was to conduct comprehensive research on the topic area. This included research on the life cycle of buildings and end of life vehicles (as a comparable principle). It needed to be established where this initiative would fit in relation to the various construction phases and the effect it would have on various building types.

A literature review was undertaken to look at the D4D principle in other countries. The aim was to look at best practice methods that have been applied and a measure of their success. A policy review addressed the current and prospective legislation/mandatory requirements that may influence the implementation of D4D.

## Survey

As part of this study we obtained construction industry feedback in relation to the existing application of D4D methods and future proposals. It was considered that the best way to do this was to create a survey based on the key principles of D4D to circulate around the construction industry in Wales. This was undertaken via the considerable network of construction professionals on the CEW database. We received limited but useful feedback that provided an understanding of the topic and a base for further interaction with the industry. Key themes included recognition of D4D in industry, application to projects, benefits, issues, the complexity of implementation and the influence of different professions. Survey questions and responses are provided in Appendices A, B and C.

## Workshop

Following the survey, it was considered to be of benefit to organise a round table workshop to discuss the project within a small group of construction industry members.

The workshop discussed the D4D principle and its current value in construction projects in order to establish the need for an action plan. We could then start to identify the priorities and actions needed in this area to bring about positive change.

These key stakeholders had a crucial role to play in this process from expressing ideas and recommendations through to the suggestion of preferred implementation options. This was an opportunity to impose their knowledge of the industry on the subject matter.

The feedback obtained in the workshop discussion has helped to inform the key findings section of this feasibility study.



# Key Findings

From extensive research, the survey and workshop exercises, we have drawn together a number of conclusions to support the viability of D4D.

Three of the most significant reasons for the continued interest and potential application of D4D were carbon emission reductions, minimisation of resource extraction and reduction in landfilled waste. The importance of sustainable construction is rapidly increasing and is stimulating a wide variety of interest throughout industry.

Sustainability benefits can only be maximised if designers, planners, developers, suppliers, construction workers, building managers and individual occupants fully understand the process. Sustainability is recognised in the construction industry as good business practice, achieved by managing impacts on the environment and society and seeing the business benefits that sustainability can bring. If we are to be successful in implementing design for deconstruction in practice, it must be viewed in parallel with the sustainable development model and considered on a whole life cost basis.

There are, however, a few constraints, such as limited availability of re-used materials, no guarantee of improved performance by using re-used materials and a lack of legislation or incentives surrounding D4D.

Following an in-depth discussion with key stakeholders at the workshop, it was apparent that the two primary issues and/or enablers for success were COST and CARBON. It is considered that these are both defining factors in the potential implementation of D4D in construction projects. Moving forward, financial incentives and consideration of the carbon impact of buildings could be the drive behind D4D. The sustainable development model supported by the whole life cost model and the whole life carbon model could be linked and provide support to any future actions.

The section below addresses the key findings using the three sustainability pillars.

## Economic Considerations

### Constraints

For the industry to adjust its approach it is important to have plausible reasons why deconstruction might be preferable to demolition. Existing constraints to the economic value of D4D is curbing the willingness of the industry to implement the principle. There is a shared opinion across the industry that D4D is likely to have high initial costs in the design period and high costs during the construction period. Clients find it difficult to justify this additional cost especially if the benefit of deconstructing is not clearly evident. The majority of the industry sees demolition as the most cost effective method of removing a building. This is unlikely to change unless a whole life cost approach is taken.

### Opportunities

Profit is a critical factor of a successful business which makes cost an integral part of incentivising a company to undertake a new, different approach to constructing a building. Despite the negative mindset towards the economic advantage of designing to deconstruct, there are still opportunities for profit gain and sustainable success. The workshop consensus identified that the main driver for implementation of D4D would need to be some form of financial incentive. This could be offered through tax incentives. This was seen as a viable solution to overcome the economic implications of designing for deconstruction on major construction projects. Whole life cost assessments would further demonstrate the long term economic benefits of D4D.

Carbon taxes may also impact upon buildings that have been designed for deconstruction. If carbon intensive processes become heavily taxed, the resulting products will increase in price. Certain building materials would fall into this category, meaning that elements within buildings that have been designed for deconstruction become more valuable. Design for deconstruction could therefore be seen as a strategy to invest in carbon. The payback would be at the building's end of life when the recovered elements could be sold or utilised in a different building by the current owner. A whole life carbon assessment would further support this approach.

Other potential opportunities for economic gain include increased project team communication, realistic budgeting for operation, maintenance and repair, assessment of material durability from the project outset and detailed performance data for future planning and benchmarking.

## Environmental Considerations

### Constraints

The increased importance of the environmental success of a development or building means Environmental Impact Assessments (if required) are thoroughly examined prior to the commencement of applicable construction projects. Although D4D intends to help address environmental issues, other issues such as transportation, energy use impacts, sprawl patterns of land development and the energy expenditure to operate buildings are all considered to have a much greater environmental impact than the use of materials in construction and future resultant waste.

Additional fabrication may also be an issue with regards to energy usage. Elements of a building may need re-fabrication after they have been salvaged to make them suitable for reuse. This will utilize small amounts of energy. Quantifying potential savings from the reuse could overcome this barrier. Alternatives need to be found to the composite slab as it still remains a major barrier with regard to the reuse of materials.

### Opportunities

The environmental benefits of deconstruction were identified to include the reuse of materials consequently leading to energy savings, a reduction in the quantity of demolition waste, minimisation of waste sent to landfill and preservation of natural materials. By reducing resource depletion we would see increased reuse rates leading to less natural resource extraction. D4D is considered one of the most important components in the green design strategy for achieving material sustainability through closing the materials loop. This in combination with potential energy savings makes D4D a very important sustainable strategy for future buildings. This approach does not intend to ignore existing buildings, as retrofit is also very much at the forefront of the carbon agenda.

## Social Considerations

### Constraints

The principle of Design for Deconstruction has been with us for some time but in spite of this it is still not particularly well recognised in the industry. It is part of the aim of the study to raise awareness and identify potential social barriers that may harm future implementation.

The industry is considered to suffer from a number of social issues which may impact upon D4D's successful implementation which include:

- shortage of skilled labour
- lack of investment in training
- poor image that leads to the inability to recruit young professionals into the industry
- inefficient working practices
- lack of coordination and communication between colleagues responsible for different aspects of the project

Community engagement is a very important part of the construction and development process and is fundamental for a design for deconstruction approach. The impact of the project on the local community must be considered and professionals must engage with the community to create strategies that provide opportunities for local SME's, training opportunities, development plans, work placements and apprenticeships.

### Opportunities

Social benefits of deconstruction as mentioned above include employment opportunities and further training prospects for those already involved in the construction industry. It could

also result in the production of materials which should be low cost and good quality and could ideally be used within the local community after deconstruction.

It is considered that designing to deconstruct should be a social responsibility of a business. It provides companies with an opportunity to instil this mindset in their employees and embed sustainability principles. This in turn could act as a key driver in improving the public image of a company.

It should not be necessarily assumed that designing to deconstruct will harm the livelihoods of the demolition profession. Deconstruction could allow demolition contractors to expand their business and potentially increase their workforce. The deconstruction of a building could require more staff, therefore benefitting the local community.

It is difficult to predict the whole structural life of a building. This could be seen as a reason for the suspected low levels of enthusiasm from the construction industry. It must be translated through education and training that it is in everyone's best interest to cater for a building that will not be demolished for another 50 - 100 years. Behaviour change is key.

From research and interaction with key construction stakeholders it would seem that D4D does have potential to become part of the development process in the construction industry. However, for it to be applied in practice it is considered that it would need to be incorporated into other best practice principles or guidance.

# Conclusions

As presented in the key findings, despite existing barriers there are also several opportunities that can be exploited to help develop the design for deconstruction approach.

Cost effective and environmentally friendly methods, education and awareness raising could all play a major role in encouraging individuals to design/construct/disassemble differently. However, there must be a reason for a change in approach. If benefits are outlined and demonstrated then there is a tangible reason to adopt a strategy. If people could quantify a benefit to their project, it gives reason to incorporate a new approach. If this new approach is deemed successful and beneficial then industry will follow. However, for this to happen impacts and benefits need to be considered in economic, social and environmental terms and over the whole life of an asset.

## Recommendations and Potential Solutions

Recommendations and potential solutions which have resulted from research, the industry survey and workshop exercise are outlined below:

- D4D requirements could be incorporated in the Environmental Impact Assessment process. This could help secure planning permission and boost the chances of a higher BREEAM rating;
- New initiatives and technologies from the University Sector in the form of training and education (RIBA Plan of Works) could be established;
- Modelling using BIM technology, pilot projects and case studies could be undertaken to demonstrate the influence that D4D can have on the end of the project or building's life. This could help highlight the sustainable benefit in D4D implementation;
- Design and building standard requirements highlighting the potential for re-use could be implemented through planning and building control;
- A D4D statement could be included within a SWMP application and deconstruction drawings and specification could be included within the Health and Safety file of a project;
- Cost benefits for implementation and penalties for non-compliance;
- Government led initiative and support;
- Enhanced emphasis on the implementation of KPIs, benchmarking and targets;
- Additional prefabrication and material specification and guidance could be provided along with improved Client and Designer learning;
- Legislative extension to the CDM regulations;
- D4D could also be driven through carbon legislation and environmental targets. A tax system could be considered to incentivize implementation such as capital gains tax and business rates;
- The implementation of a deconstruction plan or design strategy that specifies deconstruction considerations and problems associated with the safety of deconstructing buildings, or contaminated materials could help promote the implementation of D4D; and,
- Further emphasis should be given for the consideration of D4D and its communication throughout the project life. Training programmes and templates could help to promote the implementation of D4D with a particular emphasis on whole life cost analysis.

# Appendix A: Survey/Questionnaire

## Design for Deconstruction - Interview Questions

**Q1. What do you understand by the term 'Design for Deconstruction'?**

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**Q2. Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?**

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**Q3. Do you apply D4D in practice?**

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**Q4. What do you see as benefits of D4D? What do you see as the constraints in the implementation of design for deconstruction?**

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**Q5. What do you see as the current issues for D4D in**

- a.) existing
  - b.) new buildings?
- 

**Q6. What about D4D in highways projects?**

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**Q7. How can we implement D4D?**

- a.) Does planning have a role to play? Or is it a building control issue?
  - b.) Do we need to consider a legislative approach?
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**Q8. What methods would you like to see implemented to improve the efficiency of designing for deconstruction?**

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**Q9. Do you believe D4D will push the project outcome up the waste hierarchy?**

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**Q10. How could your profession influence D4D?**

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# Appendix B: Responses

## Respondent 1

### Q1: What do you understand by the term 'Design for Deconstruction (D4D)'?

That new buildings should incorporate the ability to strip and replace major elements when required so that the building can 'evolve' within its own structure allowing replacements with new and better technology and that where possible the products of demolition can be re-cycled either in the new construction as, say hardcore or externally, for instance reclaimed wood made into furniture.

### Q2: Is D4D well recognised in industry?

#### Have you been involved in a project that has considered deconstruction at the design process?

I do not think it is and although I have applied it in principle where possible. I have not been involved in any projects where it has actively been on the agenda.

### Q3: Do you apply D4D in practice?

In principle yes, trying to get consultants to design in access for replacement and renewal in projects as this has major implications for the lifetime management of FM within the building.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

There are a number of issues here: the deconstruction and removal of the whole building and the upgrading of the building throughout its life.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

One of the issues I have been advocating is a Carbon Benefit Analysis. Much like a Cost Benefit Analysis that considers the excess carbon

generated by not upgrading elements of a building plus the carbon required to dispose of or recycle those elements against the embodied carbon in the manufacture of new elements. Often the result is "If it ain't bust, don't fix it" meaning that it is often more cost and carbon efficient to accept the status quo provided the element is not actually failing.

### Q6: What about D4D in highways projects?

This makes a great deal of sense particularly giving consideration to recycling hardcore and probably tar macadam products.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Clearly the main emphasis here is carbon reduction and Planning has an effect through Environmental Impact, Building Control from the Construction element and legislatively all products should provide data on the embodied carbon in their manufacture.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Inclusion in the Environmental Impact Statement and BREEAM points initially.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Yes.

### Q10: How could your profession influence D4D?

The University Sector has an expectation to be at the cutting edge of new initiatives and technologies.

## Respondent 2

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Re Use.

### Q2: Is D4D well recognised in industry?

#### Have you been involved in a project that has considered deconstruction at the design process?

No.

### Q3: Do you apply D4D in practice?

No.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Sustainability.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

Not being considered.

### Q6: What about D4D in highways projects?

Respondent skipped this question.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Yes legislate.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Cost benefits and penalties.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Yes.

### Q10: How could your profession influence D4D?

Get legislation on it.

## Respondent 3

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

It means considering at the design stage how an asset can be best deconstructed to reduce/remove waste.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

No. Yes but only using basic principles.

### Q3: Do you apply D4D in practice?

Limited.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Benefits: drives better design, conserves resources, reduces waste.

Constraints : cultural resistance, technical knowledge, materials specification.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

a) uncertainty over existing materials spec b. BIM, lack of understanding.

### Q6: What about D4D in highways projects?

Should be equally applicable.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

a. yes, critical b. yes, supplementary c. not immediately, wait until cultural issues are addressed and knowledge improves.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Better guidance needed plus case studies.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Not sure if I understand this question.

### Q10: How could your profession influence D4D?

By applying principles through pilot projects.

## Respondent 4

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Yes, this is better known as DfD.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

It is recognised, but there are significant barriers.

### Q3: Do you apply D4D in practice?

I am not within the industry.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Benefits are multiple - better use of resources, better integration of sustainability practices during the build and subsequent use of the building. There are also many barriers, associated with quality control of products, client knowledge, architect knowledge.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

There are many positive outcomes that could be seen for DfD in existing buildings, including easier adaptability of buildings for the user, longer term usage, buildings that can be 'upgraded' in line with their original materials and features. In new buildings, it is more about getting it right from the start.

### Q6: What about D4D in highways projects?

I see this as being feasible, although the quality issue does come to the fore here.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

We need to establish a body of knowledge first - training is key, as are good guidance documents (which already exist), perhaps linking to RIBA Plan of Works, better client knowledge, but also better or easier ways to quality control reused materials to enable their use in a litigious environment. I'm not sure whether legislation is the way to go.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Not sure about this question.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Yes absolutely. If considered completely from the start, it can start encouraging better use of reused / recycled materials, which is higher up the waste hierarchy than using virgin materials. It can then look at better ways of reusing materials within the building for any modifications. Finally, it assists with the end of the life of the building, although the demolition process becomes a more costly process.

### Q10: How could your profession influence D4D?

Architects - better training to have better awareness of the issues, better able to advise clients and so on. Construction chain - again, better awareness of the process, which will include putting a building together slightly differently and moving away from some materials that are used without thinking right now.

## Respondent 5

**Q1: What do you understand by the term ‘Design for Deconstruction (D4D)’?**

Take account of the use of the structure in your original design.

**Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?**

It is not well recognised but is considered on some projects.

**Q3: Do you apply D4D in practice?**

Only very occasionally, dependent on client and type of project.

**Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?**

The re-use of materials, reducing cost of demolition. Constraints could be an increase in design and construction costs.

**Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?**

In existing buildings there are likely to be materials not suitable for re-use. In new buildings designers need to consider materials and construction processes to a greater degree and the impact across the life of the building and beyond, affecting time and cost.

**Q6: What about D4D in highways projects?**

This could affect materials and cost but it should be easier to re-use.

**Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?**

Planning has a key role along with Building Control to ensure that the design and building standards maximize the potential for efficient re-use. Unless the advantages can be demonstrated and incentives are available legislation will have to be introduced.

**Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?**

The designer should be asked to demonstrate that an agreed percentage of the structure can be recycled and/or re-used.

**Q9: Do you believe D4D will push the project outcome up the waste hierarchy?**

Yes, it should be implemented but may have to be introduced in phases.

**Q10: How could your profession influence D4D?**

As designers of both buildings and civil engineering structures we can exert an influence. However, there could be resistance from clients which can only be overcome by educating them about the advantages or incentivizing them to adopt new procedures or implementing legislation (or a combination of all 3 options).

## Respondent 6

**Q1: What do you understand by the term ‘Design for Deconstruction (D4D)’?**

Never heard of it.

**Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?**

No.

**Q3: Do you apply D4D in practice?**

Not knowingly.

**Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?**

Can't comment.

**Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?**

Can't comment.

**Q6: What about D4D in highways projects?**

Can't comment.

**Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?**

Can't comment.

**Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?**

Can't comment.

**Q9: Do you believe D4D will push the project outcome up the waste hierarchy?**

Can't comment.

**Q10: How could your profession influence D4D?**

If we knew about it, we could push more.

## Respondent 7

**Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?**

Designing for demolition.

**Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?**

No.

**Q3: Do you apply D4D in practice?**

No.

**Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?**

Not sure.

**Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?**

Funding.

**Q6: What about D4D in highways projects?**

Funding.

**Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?**

Yes.

**Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?**

N/A.

**Q9: Do you believe D4D will push the project outcome up the waste hierarchy?**

Yes.

**Q10: How could your profession influence D4D?**

Respondent skipped question.

## Respondent 8

**Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?**

Original design carried out with thought as to how a building / structure is to be taken apart at the end of life.

**Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?**

Not well recognised as a term in its own right but CEEQUAL assessed projects do involve consideration of end of life and of course CDM requires such consideration.

**Q3: Do you apply D4D in practice?**

It is considered.

**Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?**

Easier / safer dismantling. Structures are built to be durable i.e. weak spots are not desirable.

**Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?**

Existing buildings have little thought about dismantling. The materials are of low value and the most cost effective dismantling is a bulldozer. No appetite to spend time and money or to expose operatives to hazards in dismantling.

**Q6: What about D4D in highways projects?**

Limited application as highway projects are generally built to last indefinitely. There is no expectation that dismantling will take place.

**Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?**

A legislative extension to CDM could be the most effective way to ensure implementation.

**Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction? :**

Respondent skipped this question.

**Q9: Do you believe D4D will push the project outcome up the waste hierarchy?**

No, because generally the deconstruction will be too far into the future to have any sort term impact.

**Q10: How could your profession influence D4D?**

By building a commercial and safety case to support the initiative.

## Respondent 9

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Consider the CDM requirements and efficiency for access to maintain during life and for disassembly at the end of life.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

No.

### Q3: Do you apply D4D in practice?

Not really.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Longer term benefits for the client and landowner. Some early costs for design and possibly extra capital costs at the outset, which do not return benefit until the end of life.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

Nuclear power stations are a prime problem.

### Q6: What about D4D in highways projects?

Biggest problem is considering deconstruction for structures, bridges, tunnels.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Legislation is in place for the safety aspects with CDM.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

The requirement for a Deconstruction drawing and specification in the H&S File.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Maybe.

### Q10: How could your profession influence D4D?

Through advising clients early in project formation.

## Respondent 10

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Designing for dismantling and reuse, rather than simple demolition.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

No, and no. Consider decommissioning and demolition, but not really deconstruction.

### Q3: Do you apply D4D in practice?

No.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Material efficiencies. Anticipating opportunities/future needs/uses of structure elements. Most structures are designed for 100yr design life and will be used for that period (water infrastructure).

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

Understanding of application.

### Q6: What about D4D in highways projects?

No experience.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Client and designer education first, incorporate into sustainability rating systems so it can be recognised/ aspired to.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction? :

Respondent skipped this question.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Respondent skipped this question.

### Q10: How could your profession influence D4D?

Educating clients and gathering case studies/evidence.

## Respondent 11

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Thinking about demolition and reuse before something is built.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

I doubt it is formally recognised (this is the first time I've come across the acronym D4D).

### Q3: Do you apply D4D in practice?

To some extent future use / reuse is thought about but not within a formal framework.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Increased recycling of materials, less landfill, making full use of component part life by making elements reusable. Constraints will be lack of guidance, costs and getting clients to buy into it at design stage.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

a) lack of records, view of easier to knock down b)client resistance.

### Q6: What about D4D in highways projects?

Re-use of materials seems to be well advanced - continue with research to come up with long life uses for materials.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

a) Yes, definitely - we have waste management plans, why not a D4D statement with each application. b) If the economic case is a hard one to convince clients of, then legislation is in my view a viable alternative.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

More case studies / pilots with unambiguous published results - be clear about good and bad. Develop a Code of Practice collating latest experiences from across the globe.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Yes.

### Q10: How could your profession influence D4D?

Support through lobbying, assessing the benefits independently and being clear where these benefits potentially lie.

## Respondent 12

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Cradle to grave design.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

To a degree.

### Q3: Do you apply D4D in practice?

To a degree.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

H&S, future legacy, sustainability.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

Cost, legislation, responsibilities.

### Q6: What about D4D in highways projects?

Recyclable aggregates, bridge structures.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Both! Needs to be government led.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

More prefabrication.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Don't understand.

### Q10: How could your profession influence D4D?

More prefabrication, material specification, less use of materials, influence policy makers.

## Respondent 13

### Q1: What do you understand by the term 'Design for Deconstruction(D4D)'?

Consideration of future material re-use.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

No, only in consideration of CDM / safety issues.

### Q3: Do you apply D4D in practice?

It tends not to apply so much to infrastructure (roads, drainage, groundworks etc.) By their very nature, those materials will be re-usable if required.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Should aid the viability of future site/building re-use. Main challenge likely to be in specifying appropriate materials for buildings initially, or systems that dictate a particular form of construction - hence developers may perceive an impact on cost.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

Many existing buildings do not have construction details available to determine their suitability for re-use. these tend to be surveyed on a job-by-job basis.

### Q6: What about D4D in highways projects?

See answer to (3).

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

I do not think it requires a legislative approach. WRAP and other initiatives have already focused attention, and there are many other requirements (e.g. BREEAM, LEED, CFSH, B.Reggs) that will increasingly make development more sustainable. Some developers will view it as another constraint, rather than an opportunity, and if specific targets are introduced it may have a negative impact.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Needs a clear understanding by all construction professionals. Education is the key.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

Not sure what you mean. However, anything that minimises waste can only be good.

### Q10: How could your profession influence D4D?

Primarily by educating/convincing clients of its worth.

## Respondent 14

### Q1: What do you understand by the term 'Design for Deconstruction (D4D)'?

Designing for end of life.

### Q2: Is D4D well recognised in industry? Have you been involved in a project that has considered deconstruction at the design process?

Not currently.

### Q3: Do you apply D4D in practice?

Not a priority.

### Q4: What do you see as benefits of D4D? and what do you see as the constraints in its implementation?

Being able to re-use or recycle at end of life.

### Q5: What do you see as the current issues for D4D in a.) existing b.) new buildings?

a. asbestos, concrete, lead based paint. b. sips, composite panels, acrylic baths, composite baths plus many more.

### Q6: What about D4D in highways projects?

Reuse and recycling is easier here.

### Q7: How can we implement D4D? a.) Does planning have a role to play? Or is it a building control issue? b.) Do we need to consider a legislative approach?

Both planning and building control, training and education issue.

### Q8: What methods would you like to see implemented to improve the efficiency of designing for deconstruction?

Via building regulations.

### Q9: Do you believe D4D will push the project outcome up the waste hierarchy?

No.

### Q10: How could your profession influence D4D?

At tender stage.

# Appendix C: Workshop Responses

Individual/ Profession	Are you implementing the D4D principle in practice?	Why are you? OR why are you not?	What is the driving force? Please expand on previous experiences.	What is preventing you from doing it? What do you see as the barriers/obstacles?	Other Comments
Developer	Occasionally/never	Reasons for never doing it as not considered commercial viable and occasionally looks at aspects of a build however only taken forward if commercially driven. No technical issues.	Gaining commercial edge/incentives would be key drivers in implementing D4D.	<ul style="list-style-type: none"> <li>Commercial feasibility</li> <li>In appropriate commercial models(whole life owners v multiple owners)</li> <li>Lack of financial incentives</li> </ul>	<ul style="list-style-type: none"> <li>Consider tax system to incentivise. E.g capital gains tax and business rates.</li> <li>Did not consider carbon targets as a particular incentive</li> </ul>
Planning/ Building Control/ regulatory	Never	No regulatory requirement in building control or planning applications.	Legislation and environmental targets (carbon). Behaviour change with regard to component standards rather building standards.	Lack of expertise and capability within planning departments.	<ul style="list-style-type: none"> <li>Potential solution – disposal statement</li> </ul>
Structural Engineer	Occasional	<ul style="list-style-type: none"> <li>Understood environmental implications</li> <li>Financially driven</li> <li>Informally for commercial benefit</li> <li>Belief in carbon importance</li> </ul>	<ul style="list-style-type: none"> <li>Commercial</li> <li>Professional element</li> <li>Conscience</li> <li>Adaptability to change</li> </ul>	<ul style="list-style-type: none"> <li>Client apathy</li> <li>Warranties and insurances for reuse</li> <li>Safety considerations</li> <li>Commercial viability</li> </ul>	<ul style="list-style-type: none"> <li>Guidance on technical feasibility</li> <li>Financial incentives to/from the client</li> </ul>
Mechanical & Electrical Engineer	Occasionally/never	They come too late into the process to influence this. This accentuates the issues of commercial viability.	<ul style="list-style-type: none"> <li>Commercial</li> <li>Professional element</li> <li>Conscience</li> <li>Adaptability to change</li> </ul>	<ul style="list-style-type: none"> <li>Lack of joined up thinking at project development stage</li> <li>Client apathy</li> <li>Warranties and insurances for reuse</li> <li>Safety considerations</li> <li>Commercial viability</li> </ul>	
Architect	Always thinking, never achieved	<ul style="list-style-type: none"> <li>Not embedded in the design process</li> <li>Professional responsibility</li> <li>Client reluctance/ apathy/refusal</li> </ul>	<ul style="list-style-type: none"> <li>Professional responsibility</li> <li>Commercial edge</li> <li>Optimum whole life cost model</li> </ul>	<ul style="list-style-type: none"> <li>Warranties and insurance</li> <li>Safety considerations</li> <li>If demolition costs representative a small proportion of the whole life costs e.g total running costs</li> </ul>	
Building Surveyor	Always considered, occasionally carried out	<ul style="list-style-type: none"> <li>Not embedded in the design process</li> <li>Professional responsibility</li> <li>Client reluctance/ apathy/refusal</li> </ul>	<ul style="list-style-type: none"> <li>Professional responsibility</li> <li>Commercial edge</li> <li>Optimum whole life cost model</li> </ul>	<ul style="list-style-type: none"> <li>Warranties and insurance</li> <li>Safety considerations</li> <li>If demolition costs representative a small proportion of the whole life costs e.g total running costs</li> </ul>	
Demolition	Occasionally/never	Instructed by clients	Commercial	Client apathy/ reluctance	

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