VALUING THE PRE-DEMOLITION AUDIT PROCESS

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ABSTRACT

The aim of pre-demolition audits is to provide valuable information that can be used by client, architect, engineer, construction contractor and manufacturing industry to optimise the existing buildings as part of the decommissioning, deconstruction and demolition process. The deconstruction case study audits performed by the Building Research Establishment (BRE) for a Government-funded project are the first of their kind in the United Kingdom (UK) for a range of building types. This paper presents a summary of these results and proposals to increase the reuse of construction materials following demolition.

The seven pre-demolition audit case studies bring together research and information from a large number of sources as well as site survey information. Each case study also benefits from the incremental development of the auditing and valuation process that made significant changes during the two-year project. The case studies have assisted project teams to reduce the cost of disposal of the old buildings, realise financial benefits from reclaimed materials and quantify the environmental benefits of reusing and recycling.

The final report delivered to UK Government in 2002 included pre-demolition audits, reclamation valuation surveys and environmental quantifications for a select range of materials and products expected to be generated from the demolition of the existing buildings and structures. Together these indicate key demolition products, their potential for reuse, the potential range of economic value (revenue) from resale, and the environmental rewards in terms of Ecopoints and Hectares of selectively logged Amazonian rainforest over one year. Together this information provides an indication of what environmental rewards can be realised by the UK construction industry through informed waste management practices.

KEYWORDS: Deconstruction; Pre-demolition Audit; Reclamation Valuation; Environmental Quantification

INTRODUCTION

This paper reports on the technical, economic and policy issues that must be addressed to make reclamation and recovery of building components and materials a viable alternative to landfilling. The key recommendation to Government is for future projects to include a pre-demolition audit, a reclamation valuation survey and an environmental quantification of the building structure and contents prior to tender. This would complement the Demolition Code of Practice BS6187-2000, the Construction (Design and Management) Regulations 1994 (CDM) and the Health and Safety Executive (HSE) Health and Safety in Demolition Work. It would also maximise the potential of the former structures, encourage high-grade recycling or reuse and reduce dependence on landfills. Naturally this approach will require drivers in the form of regulation and the co-operation of clients and developers.

This paper includes results of pre-demolition audits, reclamation valuation surveys and environmental quantification of a select range of materials and products expected to generate from the demolition of existing buildings. Together these indicate the key demolition products, their potential for reuse, their economic potential (revenue) and environmental rewards in terms of Ecopoints and Hectares of selectively logged Amazonian rainforest. The information can help the project teams reduce the cost of disposal of the old buildings, realise financial benefits from reclaimed materials and quantify the environmental benefits of reusing and recycling. The audit process has progressed over two years to the level of detail as provided for the Whipps Cross University Hospital (WCUH) site in London. One thing is clear - the level of detail in the audits required for one project will be dissimilar to that of another project due to the nature and style of the structures.

In most cases of demolition, the best chance for reuse will be in the new development, which would be pioneering in itself. This will require imagination and the co-operation of a strategic partnership in order that the essence of the former buildings is captured into the new. Ideally this would optimise the potential outlined in this paper, but in real terms some materials will have to be recycled (hopefully up-cycled) off-site or sent to landfill.

PRE-DEMOLITION AUDIT RESULTS

Prior to demolition, it is useful to categorize a site not only in terms of the location of hazardous materials and chemicals (see BS6187-2000) but also the type and condition of the structure and internal fixture and fittings. SMARTWasteTM (Site Methodology to Audit, Reduce and Target Waste) has been developed by BRE to provide a robust and accurate mechanism by which wastes arising can be benchmarked and categorised by source, type, amount, cause and cost. This tool has been adapted to perform pre-demolition audits and provide case studies for this project. A pre-demolition audit provides a list of key demolition products (KDP) that can be assessed using a reclamation valuation survey and translated into embodied energy and hectares of rainforest as an indicator of environmental quantification.

SMARTWaste audits have been completed for construction, demolition, refurbishment, manufacturing and pre-fabrication. The data is a springboard to identifying and prioritising actions to reduce waste (producer responsibility), reuse at source (proximity principle), and maximise recovery to extend materials' life-cycle. The benefits of the software tool are to identify the potential true cost savings of projects and maximise the reduction, reuse, recycling and recovery options of materials. Further examination of the software provides a range of features such as instant reporting tailored to clients needs, sharing of information, establishing environmental performance indicators, and development of integrated material waste management strategies.

Undertaking pre-demolition audits is an interesting task but challenging where little or no information is available. Some demolition projects may have a wealth of blueprints and sectional drawings that can be of great help to interpret the construction techniques used in the structure and where and what materials have been used. In these circumstances much of the interpretation and audit can be completed as a desktop study and complemented by visits to confirm the blueprints. However for most projects this information is not available and must be gathered through a combination of audits and site visits. In all cases it is necessary to visit the site to investigate the quality, condition and fixture of the products and components and to witness their financial value and availability for deconstruction and reuse. Time spent on site is dictated by the nature and size of the buildings and the availability of information.

The results included in this paper build on the results presented at the TG39 meeting in Germany in 2002. For some of the case studies it was sufficient to concentrate on the overall volume of mass materials and ignore the furnishings and fixtures, in others a detailed account of decorative and furnishings was included. It was felt that this was a necessary process to go through in order to discover which was the most appropriate method or protocol to use for auditing. In retrospect, it identified the variable nature, condition and quality of the buildings and key demolition products that each needed specific audit requirements. The result was the ability to concentrate on products of value and suitable quality for deconstruction and reuse and not on the complete structure. In this way the audits serve to provide reasonable information that can be commercially accessed. In the six case studies doors, floors, windows and cladding were included. Asbestos materials were excluded from all the audits, as were chemicals, underground services, electrical appliances, and hospital equipment.

Multi-Storey Housing
This was a 22-storey building in Liverpool that was demolished following the strip-out phase using a controlled explosion technique. A pre-demolition audit was undertaken to show the volumes of waste materials and products within and embodied into the buildings.

Housing
This was a 3-storey block of housing in Manchester that was demolished using traditional demolition techniques of soft-strip followed by mechanical pulverisation. A pre-demolition audit was undertaken to show the volumes of waste materials and products within and embodied into the buildings.

Factory
The Sanderson factory complex near the centre of Uxbridge, West London. This factory was used for manufacturing textiles, and was split into two parts covering an area of 18,324m^2. Approximately two-thirds of this building was the factory itself (12,636m^2), with the remaining third being a warehouse (5,688m^2) used for storing products produced in the factory. The warehouse also contained a number of offices.

Multi-Storey Offices
This is a collection of six 5-storey buildings in London that are currently being refurbished over a 5-year programme. A pre-refurbishment audit was undertaken to show the volumes of waste materials and products within and embodied into the buildings. This was a very detailed audit including all furniture, fixtures and fittings. Some graphs generated for this project are included later in this paper.

Factory
This case study was undertaken on behalf of Norfolk County Council, Norwich City Council and Bovis Lend Lease. The aim of the study was to investigate the possibilities of Deconstruction

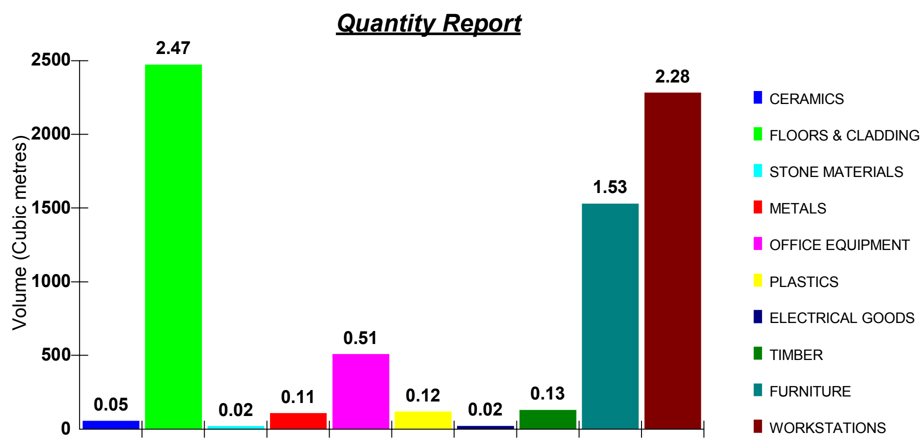
and reuse of construction materials from demolition of the former Nestle chocolate factory in Norwich - otherwise known as Chapelfield.

Hospital

The aim of this case study was to provide information that could be used by the Whipps Cross University Hospital (WCUH) project team to optimise the existing buildings as part of the hospital redevelopment. This is a 10-year, phased programme that started in 2001. Some of the recommendations in this paper are based on the pre-demolition audit of the WCUH site carried out by BRE, the first of its kind for a hospital in Europe.

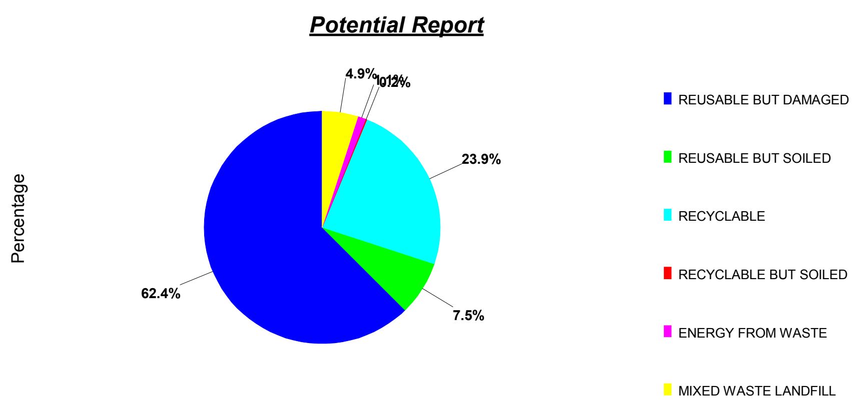
Figure 1-4 show the overall results of one case study in terms of quantities and optimal reuse-recycling potential for all material groups and a detailed example for metal materials (these graphs were included in the previous TG39 paper).

Figure 1: Overall quantity of materials from the multi-storey offices



Total quantities for all groups in all buildings (©SMARTWaste)

Figure 2: Reuse / Recycling of materials from the multi-storey offices



Reuse-Recycling potential of all waste for Jespersen Street
(©SMARTWaste)

Figure 3: Overall quantity of metal materials from the multi-storey offices

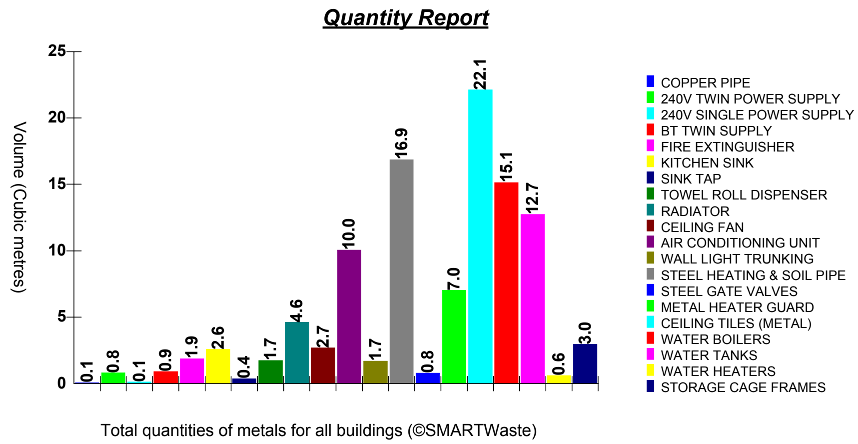
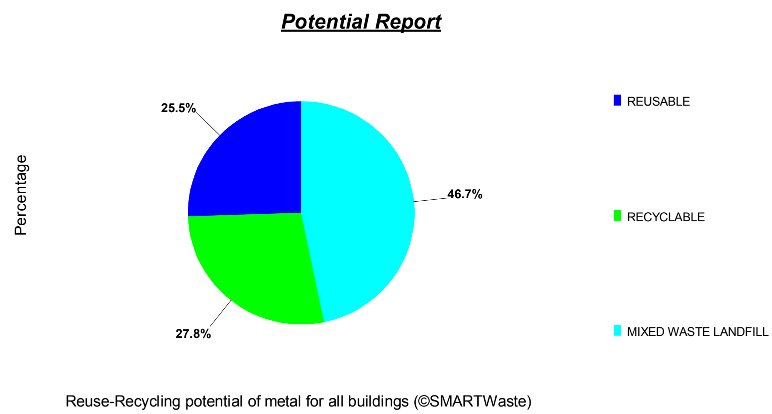


Figure 4: Overall potential for metal materials from the multi-storey offices



In addition, tables were prepared for the audits and proportionate examples of two types of table are included in Figures 5-6 below.

Figure 5: Example of the detailed audit of materials from the multi-storey offices

BUILDING FABRIC	Dimensions (cm)			Waste Potential	B13	B8	B36	Haddon	Howland	Maple	Total
	length	width	depth								
Air conditioning unit	90	90	20	Mixed landfill	0	4	51	2	5	5	62
Aluminium partitions (m)	100	269	7	Recyclable	24	34	211	162	71	0	502
Aluminium window frame	268	125	13	Recyclable	159	168	133	277	252	0	989
Ashfelt roof (m^2)	100	100	1	Mixed landfill	283	250	0	461	747	0	1741
Battery emergency light	38	14	9	Mixed landfill	7	8	12	7	9	3	46
Brick & concrete cladding	126	84	25	Inert landfill	159	168	133	277	252	0	989
BT twin supply	15	9	5	Mixed landfill	204	164	400	251	214	109	1342
Carpet (m^2)	100	100	2	Mixed landfill	260	0	890	0	0	0	1150
Carpet tiles	50	50	1	Mixed landfill	6240	8960	24920	12628	11880	3976	68604
Ceiling fan	80	80	10	Mixed landfill	8	12	18	0	4	2	42
Ceiling tiles (fibrous)	60	60	2	Mixed landfill	9066	22555	15356	8771	2376	0	57924
Ceiling tiles (metal)	60	60	2	Reusable	0	0	3072	0	0	0	3072
Ceramic tiles (m^2)	100	100	1	Inert landfill	132	176	408	469	168	72	1403
Circular light (large)	46	46	10	Mixed landfill	16	35	4	14	8	3	78
Circular light (small)	30	30	10	Mixed landfill	29	65	17	5	35	0	147
Copper pipes (m)	100	1	1	Recyclable	92	84	148	100	88	32	528
Double electric socket 240V	15	9	5	Mixed landfill	212	213	376	259	129	0	1189
Fire door & frame	218	108	10	Energy from waste	21	19	34	8	2	16	96
Fire extinguisher	50	14	14	Reusable	32	20	40	35	40	26	191
Fire hose	57	57	28	Mixed landfill	0	0	1	0	12	0	13
Kitchen cupboard	100	70	40	Energy from waste	18	26	12	23	23	2	96
Kitchen sink	105	53	33	Mixed landfill	4	0	2	6	2	2	14
Lift hardwood door frame	198	22	3	Recyclable	37	40	40	35	20	0	170
Metal heater guard (m)	100	20	1	Recyclable	483	576	938	763	625	127	3512

Figure 6: Example of Key Demolition Product Targets for the multi-storey offices

INTERNAL FURNISHINGS	Dimensions (cm) length	width	depth	Waste Potential	Total	Target %	Achieved %
Ceiling to floor cabinet	240	103	54	Energy from waste	64		
Circular table	120	120	73	Reusable	149		
Coffee table	120	60	43	Reusable	12		
Corner desk workstation	200	80	73	Reusable	815		
Desk partition (desktop)	180	49	3	Reusable	275		
Desk partition (large)	120	120	5	Reusable	479		
Desk partition (medium)	120	80	5	Reusable	21		
Desk partition (small)	120	40	5	Reusable	314		
Desk partition (X-Large)	160	120	5	Reusable	69		
Desk shelf	180	32	2	Reusable	598		
Dexion-style shelf units	220	100	32	Recyclable	216		
Dishwasher	120	80	70	Reusable but soiled	3		
Double comfy chair	200	80	70	Reusable but soiled	33		
Double filing cabinet (mid)	120	105	47	Reusable	282		
Double filing cabinet (small)	80	70	47	Reusable	173		
Double filing cabinet (tall)	196	105	47	Reusable	170		
Electric fan	50	35	26	Reusable	361		
Fancy oblong table	180	80	73	Reusable	66		
Fridge	120	80	70	Reusable but soiled	21		
Hat stand	190	5	5	Reusable	57		
Industrial cooker	100	90	90	Reusable but soiled	3		
LCD projector	40	25	12	Reusable	3		
Metal frame plywood table	114	86	74	Recyclable	918		

The results for each of the six buildings audited are aggregated in the Figures 7-8 below to show the overall variation between the types of wastes being generated and the reuse / recycling potential for the key demolition products. Naturally the variation in materials will be determined by the construction type but the reuse/recycling potential will be as much about how the materials were bound together as well as the quality and condition of the materials. These are most important indices to record during the audits in order that appropriate decisions can be made. Figure 7 shows that the most common materials were hard, inert fractions such as concrete, stone and ceramics. Timber was also significant in some buildings and, when considered, the furniture, furnishings and fixtures could also be of significant size.

Figure 7: Variable percentage quantity of materials from the six case studies

	Multi-storey housing	Prefab Housing	Factory	Multi-storey offices	Factory	Hospital
Ceramic	2.3		9.3	1	16	67
Metal	3.1	0.4	2.8	1.5	2	1
Furniture	2.3			59.9	1	
Plastic	0.6	1.1		1.7		1
Concrete	86.8	85.2	86.5	34.1	78	12
Timber	3.5	7.7	1.4	1.8	2	19
Miscellaneous	1.4	5.6			1	
Total	100	100	100	100	100	100

Figure 8 shows that there is commonly substantial opportunity to reuse as well as recycle. Despite this fact the great majority of materials will be down-cycled and neither up-cycled nor reused. Although recycling is much more preferable than combustion or landfill, we should continue to find greater opportunities to reclaim and reuse key demolition products where possible and account for this both economically and environmentally.

Figure 8: Variable percentage potential for reuse / recycling for the six case studies

	Multi-storey housing	Prefab housing	Factory	Multi-storey offices	Factory	Hospital
Reusable	2.9	69.9	6	41.8	12	74
Recyclable	89.9	23.9	89	27.3	86	24
Combustion	5.3	1.3		3.4	2	1
Inert landfill				17.1		
Non-hazardous landfill	1.2	4.9	5	10.4		1
Hazardous landfill	0.7					
Total	100	100	100	100	100	100

VALUE THE AUDITING PROCESS

Reclamation Valuation & Environmental Quantification

In order to appreciate the 'potential' to reuse and recycle there is an urgent need to include a value of the various costs for demolition, deconstruction and soft strip. This should include costs for both plant and staff time. This will not be an easy task and will require weightings for geographical and technological variations. There is also an environmental cost to consider that is even more difficult to ascertain. The reclamation valuation surveys herein were undertaken by Salvo (who represent the reclamation industry) and attempt to provide indicative revenue for materials and components that could be reclaimed for reuse. Similarly, the environmental quantification provided by BRE provides an indication of the environmental rewards to be realised from reusing and recycling. Reclamation valuations and environmental quantifications were undertaken for two of the case studies; Whipps Cross University hospital and Nestle factory. A number of assumptions were made for the studies. The common assumptions were:

- All reclaimed items have been removed from the building without damage, and not been damaged during any transport or processing to enable reclamation.
- The installation of reclaimed items has involved the same environmental impact and wastage of materials as the installation of new items.
- The service life of reclaimed items is the same as new items.
- Most reclaimed items have been removed from site, taken to a separate site to be processed and stored, and then transported to a new development.
- All transport has been based on UK Government Transport Statistics providing typical loads and distances for different materials.

The aim of the environmental quantification is to quantify the environmental rewards for reusing or recycling construction materials, as opposed to allowing post-demolition materials to enter the waste stream and using newly manufactured construction materials. The assessment was undertaken using the BRE Environmental Profiles Methodology, which uses a level playing field approach to assess environmental impacts over the whole life cycle. The assessments therefore take account of any environmental impacts associated with transport, manufacturing and processing, maintenance and replacement, and disposal at the end of life. These are based on typical UK scenarios. The BRE Environmental Profiles Methodology measures 12 Environmental impacts:

Climate Change	Acid Deposition	Ozone Depletion
Human Toxicity to Air	Low Level Ozone Creation	Fossil Fuel Depletion
Human Toxicity to Water	Ecotoxicity to Water	Eutrophication
Minerals Extraction	Water Extraction	Waste Disposal

For this study an overall measure of the environmental impact known as Ecopoints was used. 100 Ecopoints is equivalent to the overall environmental impact of one UK citizen over 1 year. The study also provided a measure of Embodied CO_2 in terms of the hectares of Amazonian rainforest that would be needed to sequester the same amount of CO_2 from the atmosphere. This study has taken the amount of carbon sequestration provided in the Intergovernmental Panel on Climate Change (IPCC) report for selectively logged rainforest in Amazonia of approximately 2.5 tonnes of Carbon per hectare per year. Interestingly, a hectare of sustainably managed English oak would also absorb 2.5 tonnes of carbon per hectare per year.

Figure 9: Overall reclamation valuation and environmental quantification for WCUH

	Reclamation Valuation				Environmental Quantification		
ALL PRODUCTS (m^3)	STTOD - sold to the trade, own dismantling	STTG - sold to the trade at the gate	SOS - sold on SalvoWeb	RVO - reuse value on-site	Ecopoints	Hectares pristine Amazonian rainforest per year	Hectares heavily logged, sustainably managed rainforest per year
24,515 m^3	£456,995	£2,107,442	£6,952,402	£4,227,529	119,121	2,516	1,060

As an example of what can be achieved, Figure 9 provides a summary for WCUH. These show the economic potential for 24,515 m3 of key demolition products that could realise an income of between £456,995 - £6,952,402 depending on the form of deconstruction used. Avoiding landfill disposal by reusing or recycling the KDP could save a further landfill tax charge of £34,000 which could easily triple by the end of the project. This would also reduce the estimated 3,064 lorry journeys required for the disposal of the demolition waste and minimise the number of lorries required to deliver new materials to site. These benefits may be used to complement any planning applications that are required. Similarly, reuse and recycling can help realise environmental rewards that are similar to the environmental impact of 1,191 people over 1 year or the amount of carbon sequestered by 1,060-2,516 hectares of rainforest. Figure 10 provides individual examples of the 39 KDP audited at WCUH.

Figure 10: Reclamation valuation and environmental quantification for select KDP

PRODUCT	Reclamation Valuation				Environmental Quantification		
	STTOD - sold to the trade, own dismantling	STTG - sold to the trade at the gate	SOS - sold on SalvoWeb	RVO - reuse value on-site	Ecopoints	Hectares pristine Amazonian rainforest per year	Hectares heavily logged, sustainably managed rainforest per year
Leaded cupola (intact)	-£32,000	£0	£24,000	£80,000	0	0	0
Dressed red rubbers (brick)	£2,800	£7,000	£18,200	£5,600	263.2	6.44	2.716
Handmade reds (brick)	£452,696	£1,810,783	£5,885,045	£2,716,175	85106.801	2082.40045	878.229755

In order to appreciate the detailed value in Figures 9-10 above, a brief description for one of the KDP is explained. Handmade red bricks are quite commonly used in the pre-1920's buildings at WCUH. The value of one handmade red brick dismantled by the demolition team to sell off-site will be only 5p, whereas to dismantle it and sell it to the trade on-site will be 20p. Sold via the Salvo website it is estimated that each of this type of brick could fetch 65p; to replace a new brick being used for the new hospital is 30p. It is estimated that approximately 9-million handmade red bricks are available for reuse with an economic potential between £0.5-million and £5.9-million. These are significant figures to consider.

The approximate environmental quantification -or reward- for adopting reuse of the handmade red bricks on- or off-site is significant. Each of the handmade red bricks is equal to 0.0094 Ecopoints – the impact of one UK citizen over 50 minutes. Similarly, one brick is equivalent to the Carbon sequestered by 0.00023 hectares of pristine Amazonian rainforest or 0.000097 hectares of heavily logged, sustainably managed rainforest over one year. The potential environmental rewards for reclaiming and reusing the handmade red bricks from WCUH is equivalent to the environmental impact of 851 people over 1 year or between 878 - 2,082 hectares of pristine / sustainable logged rainforest per year.

Process Mapping

However, to realise the potential to reuse and recycle there is an urgent need to value the various costs for demolition, deconstruction and soft strip for both plant and staff time. This is not a simple task and will require weightings for geographical and technological variations. There is also an environmental cost to consider which is even more difficult to ascertain. Recently, BRE has been undertaking process maps of the demolition process for both the Department of Trade and Industry (DTI) and the Waste and Resources Action Programme (WRAP) projects using the baseline principles of the Calibre tool. The following provides a brief insight into the process mapping of the soft strip process at the former Nestle factory in Norwich.

Many items were removed, including partitioning panels, cupboard doors, single doors double doors, wardrobes, shelves, doorframes, architectural timbers, handrails, unique wardrobes and skirting boards. Steel shelves were also removed and used for storage of the items removed from the building. All nails were removed from items. Doors were also removed in one of two ways, firstly with all the fixings attached, secondly with all the fixings removed. At all times the disturbance of asbestos panels was avoided.

Process mapping provide a better understanding of the barriers and opportunities to deconstruct and helps to clarify the roles and responsibilities of participants, having real-time feedback of activities involving all levels of staff. It also helps to identify and eliminate disruptive patterns and process bottlenecks, thereby improving site organisation and developing more expedient design solutions. The process mapping helps the process become more efficient, more competitive, and more predictable in the delivery of the product and improves performance. The following table shows select results of the process mapping and average times.

Type	Dimensions (m)	Volume (m3)	Average Time (min)	Staff	Equipment
Partitioning Panel	2.9 x 1.2 x 0.05	0.17	12	2	Screw driver, steel bar
Other Panels	2.9 x 1.2 x 0.05	0.17	3	2	Screw driver, steel bar
De-nailing	1.5 x 0.060 x 0.010	0.0009	0.5	1	Pillar
Cupboards doors	0.685 x 0.520 x 0.025	0.54	4.5	1	Screw driver
Single door With fixings	1.9x0.640x0.045	5	5	1	Screw driver

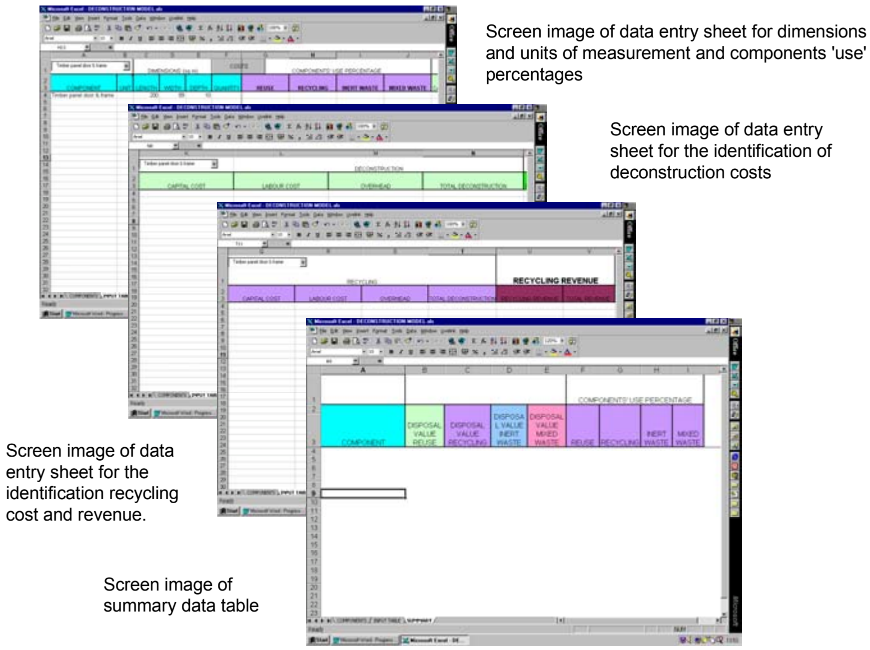
Yet what is the additional cost of adjusting the process? How is it we can choose one process over another and what value should we place on that change? BRE has recently developed a procedure and cost model to make an economic assessment of the cost and benefits of deconstruction and reuse of building materials. Discussions with industry highlighted that, whilst the principle of the model and that the procedure are sound, significantly more development and research is required to create a model that would add value to the industry.

The foundations of the cost model are based on basic principles of economic theory. Economics is a study about how scarce resources are allocated in a world where there are constant demands. Factors of production are usually classified into four different groups of entities; Land, Labour, Capital and Enterprise. The deconstruction cost model adopted an approach based on the economics of allocation of scarce resources, and created a methodology that can measure the quantities of scarce resources that have to be employed to deconstruct and then reuse construction components and materials in a way that can maximise the economic value added.

The model uses costs and prices as a method to rank the various ways to deconstruct and opportunities for re-sale of the building components. Prices are used to perform the allocation system, as they provide the information and incentives needed to make rationale economic decisions in order to arrive at the optimum outcome. A prerequisite of a tool is that it is capable of ranking decisions based on a defined measure. The cost model fitted this description as it attempts to rank alternative approaches to deconstructing a component- the defined unit of measure is cost. A more complex model could include benchmark prices that each factor of production can command, typical costs for deconstruction, including for example, typical labour rates, and cost of hiring capital. A more complex model would add value if it also considered how influences such as building design, construction methods, location, infrastructure would affect the cost and income earned by deconstruction and reuse. A predictive cost model for deconstruction and reuse of materials can be developed but it needs to be practicable and usable.

The model creates a systematic approach for identifying and summing the costs of deconstruction products, and add value to the Whole Life Cost (WLC) arena by creating a better understanding of the costs and revenues incurred when a KDP has reached the end of its (current) economic life. Maximising the disposal value of a component may have significant cost savings for the construction industry clients. Including the disposal value in WLC calculations of an asset help ensure that procurement of construction products are chosen which offer best value.

Figure 11: Screen Dumps of the Deconstruction Cost Model (included in previous paper)



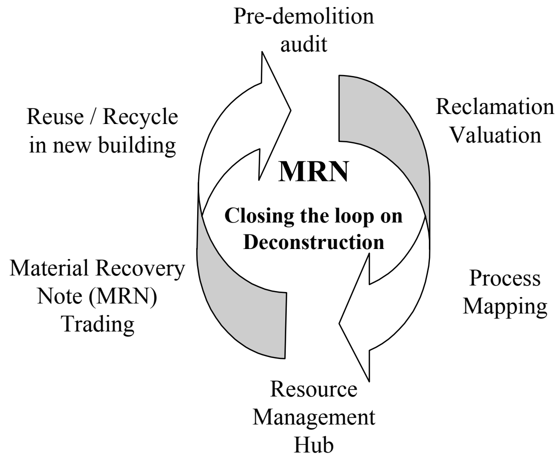
The cost model is one possible way to the economic benefits of reusing salvaged buildings rather than sending them to a landfill.

Funding Change – Material Recovery Notes

Material Recovery Notes (MRN) are an idea, a potential opportunity to extend the principles of packaging recovery notes (PRN's) to reclaimed materials. It is well known that the PRN system has helped to develop the recycling industry; the MRN system could provide similar assistance to the reclamation industry. However, this is merely an idea arising out of the industry's apparent willingness to develop the reclamation and reuse of construction materials if there is sufficient demand, supply, time and collaboration. The MRN system could provide this framework.

The MRN system would aim to close the loop on deconstruction and minimise the level of demolition to materials earmarked for recycling, composting, recovery of energy or landfill (including inert supplies which are a necessity). The MRN system would also help the WLC model to accommodate multiple life materials rather than one-life accounting. Despite best efforts, WLC models are lacking sound, reasonable data for their models, hence the urgent need to gather this information before we unnecessarily demolish our historic buildings and architectural products and resign them to landfill or at best down-cycling as crushed or chipped materials. The MRN system would be able to capitalise on pre-demolition audits, reclamation valuations, environmental quantification and process maps described in this paper. Figure 12 shows the basic principles of the closed loop approach.

Figure 12: The MRN - Closing the Loop on Deconstruction



To support the MRN system a key demolition product template should be developed, whereby the information gathered on a particular product could be advertised in advance of, or following, the deconstruction process. Vital information from the pre-demolition audit, reclamation valuation, environmental quantification, process mapping, WLCcomparator, risk analysis, method statement, specification, cost and comparable revenue could be made available to potential purchasers. Once a purchase was made the MRN trade would be completed along with the environmental rewards.

The MRN system and key demolition product template is not entirely a new concept as the reclamation industry has been trading architectural and antique products and materials for many years. Salvo has played a significant role in the development of this trading and quality control and it is anticipated that a national resource management hub will align itself, and capitalise on, existing and developing systems. However, it is necessary to consolidate all this information under one umbrella and draw upon the range of information, regulation and specification to assist trading and reuse of suitable products and materials. In this way it will be possible to provide a portal to engineers, architects, specifiers and clients in need of reassurance that they are making sound business decisions that the City and insurers will approve.

To conclude this paper, it is paramount to recognise that Client-led initiatives will be required to achieve a reasonable level of reclamation and reuse of materials. A Form of Tender should include the requirement of a pre-demolition audit, reclamation valuation and environmental quantification of the former structures. These should then stipulate which key demolition products the project team wish to ring-fence for reuse on site and stored on land set-aside or rented locally for temporary processing and storage. Ideally the land will be organised by the demolition contractors themselves as part of the tender. Invitations should make it clear that preference may be given to tenders with voluntary method statements that maximise the reclamation of building materials. The remaining materials not earmarked for reuse on site should then be advertised locally and nationally in order to capitalise on the best practicable environmental option. In this way it will be possible to maximise potential and reduce our dependence on landfill.

For the purposes of this paper, BRE has provided pre-demolition audits, reclamation valuation surveys and environmental quantifications of a select range of materials and products expected to generate from the demolition and deconstruction of a range of buildings. These tools constitute a valuable advance in determining how clients can appreciate the nature, make-up and value (economic and environmental) of their structure prior to demolition. In itself, this paper does not answer all the questions or provide a complete analysis of the potential to deconstruct and reuse construction materials both on- and off-site. What it does provide is an incentive to identify KDP and their potential/value for reuse, and what are the environmental rewards in terms of Ecopoints and sequestered CO_2 from hectares of Amazonian rainforest. Together, this information provides a sound foundation to build on and offer opportunity where it exists.

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