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Purpose of the Series

The aim of this publication is to provide an opportunity for students to publish the findings of their undergraduate or postgraduate work. Guidance on publication will be given by staff who will act as second authors. It is hoped that by providing a guided transition into the production of papers that students will be encouraged throughout their future careers to publish further papers. Guest papers are welcomed in any field relating to the Built Environment. Please contact E.A.Laycock@shu.ac.uk. A template will be provided on request.

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EDITORIAL

It is a pleasure to introduce this, the first issue of the Sheffield Hallam University Built Environment Research Transactions.

Publication of postgraduate Built Environment research has long been encouraged at Sheffield Hallam University, and such work has therefore been more likely than undergraduate work to reach a public forum. This volume makes available for the first time in one publication some of the excellent work produced by both undergraduate students and postgraduate students alike.

It is hoped that over future editions this journal will continue to showcase some of the best examples of our students' work and to allow others to benefit from their extensive and illuminating research into current and arising issues within the all disciplines encompassed within the remit of the Built Environment.

The aim of the journal is to bring this current knowledge to readers in both paper and virtual formats in the hope that this is useful and relevant and to encourage our graduate students to publish throughout their future careers.

I would like to thank all contributing authors and co-authors for their efforts in writing these papers, and the editorial team for their constructive and helpful feedback.

Dr Elizabeth Laycock
Editor, Built Environment Research Transactions

CONTENTS

DEVELOPMENT CONTROL RESEARCH AND THE VIABLE SYSTEMS METHOD

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Catherine Wynn graduated in 2002 with a 2.1 in Law and Criminology from Sheffield University. She completed a Post Graduate Diploma in Town and Country Planning and a Diploma in Systems Practice while working as a Planning Officer. She commenced her Full Time PhD in September 2007. This article is based on research undertaken for her PhD on the Management of Local Planning Authorities supervised by Dr Ernie Jowsey and Dr Barry P Haynes. Dr Barry P Haynes is the subject group leader for the Property Development & Refurbishment subject group. Barry has a research interest in new ways of working and office design. An area of specific interest is the impact the office environment has on occupiers' productivity. Dr Ernie Jowsey is a Principal Lecturer in Environmental Economics. His research interests concern the investigation of the physical and economic characteristics of natural resources with the aim of establishing criteria to enable their sustainable utilisation in order to protect the environment.

The use of quantitative indicators to monitor planning performance has been a subject of debate for many years (for example, Brotherton, 1982; McNamara & Healey, 1983 and Larkham, 1990). In recent years, this target culture has been further emphasised by the funding, allocated according to performance, of the Planning Delivery Grant. While initially central government seemed to reject the idea that these targets could adversely impact service delivery (for example, Office of the Deputy Prime Minister, 2004), recent reports, set in the light of the recent economic environment, seem to acknowledge the 'unforeseen' consequences of the emphasis on targets (The Killian Pretty Review, 2008 and National Audit Office, 2008). Systems practice is a study of management which seeks to focus on ‘problems arising from interactions among elements of society, enterprises and the environment’ (Miser & Quade, 1985, 2). Within the field there are a wide range of methods and techniques which are used to explore the interactions between elements of systems and the responses and consequences that occur. The viable systems method focuses on the ability of a given system to remain as a viable entity by examining its structure in relation to its capability of adaptation to changes in its environment. This paper proposes an intended framework for the studying the area of development control management, introducing the work of Stafford Beer and his Viable Systems Model and exploring the applicability and the role in which systems analysis could play in the research of development control. Through a brief analysis of the use of targets, and other data, which have been used within the management of the English development control system it will identify the issues which surround the current reductionist monitoring practices. It will establish that changes to practice should be fully considered in light of the environment in which they lie and that they should be viable and sustainable in the light of changes in this environment. The Viable Systems method is presented as a suitable means to analyse the practices and as a basis for proposals for this to be achieved.

Keywords: Development Control, Methodology, Systems Analysis, Target Setting, Town Planning Management, Viable Systems

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INTRODUCTION

The Development Control system has, in recent years, been subject to a large amount of scrutiny in relation to the speed at which the process operates and, consequently, at which decisions are being made. As such the performance of councils in this area has been seen to improve with planning applications being determined faster. However, as this performance' improvement' has occurred, people have begun to question whether the output of the authorities has been affected by this focus, and to explore what the management of the authorities is seeking to achieve.

This paper discusses the use of targets within Development Control, and the practices used to achieve these targets, before examining in more detail two recent government reports which investigated, amongst other things, the influence of the targets and good practice before making recommendations to be implemented to produce improvement to the speed of the planning system in the future.

Finally, this paper will move to explore the potential role of viable systems analysis and its applicability to the Development Control field, in particular in assessing the ability for new recommendations stemming from the recent reports to be implemented. By examining these particular recommendations the study will assess the overall ability of local authority development control departments to adapt in a sustainable manner to changes to the environment in which they are situated.

TARGETS AND STATISTICS IN DEVELOPMENT CONTROL

It is difficult to determine effective techniques for investigating practices within Development Control. Much research is dependent on the data collected as a means to monitor performance through the use of specific targets as indicators. Predominantly this has focused on the speed of determination of planning applications. However, does an increase in the speed of one element of the development control process accurately portray the quality of the entire system?

Caution in the use of this type of data has long been advised. McNamara and Healey stated, in 1984, that, 'Development control data must be… used with great caution. Wherever possible it should be accompanied by detailed research into the informal aspects of the land use planning process and the discretion used by development controllers… the use of such data for monitoring the 'efficiency' of local planning authorities is also very hazardous'.

Similarly, Morrison and Pearce (2000) stated succinctly that 'indicators indicate' and that they cannot demonstrate the causal links or provide explanations as to why the system is changing. It is these links between the entire system and its environment which it is necessary to further explore.

Meanwhile, academic discussion has continued to address performance in relation to this aggregate data. Enticott (2006), used the target indicators when investigating the impact of internal management on authority performance. His work inherently links the performance and management of an authority to the limited statistics based on speed of determination of planning applications.

The current targets for the monitoring of Development Control decisions in England were first introduced following a review conducted by the Department of Environment in 1975. The time limit was, at this time, considered to take account of the essential need for public involvement within the process and was set accordingly with 8 weeks for planning applications (Department of Environment, 1975). It was later further refined in response to the need to allow increased time in response to the increasingly level of complexity of the planning system. Therefore, in 2002, a 13 week time limit was introduced for major planning

applications which include, for example, a residential development comprising of 10 or more dwellings (DTLR, 2002).

These targets gained more emphasis under the Labour Government through the introduction of the best value performance indicators (BVPI's) and the council wide comprehensive performance assessment regime. The existing targets became part of this scheme as BVPI 109 and are now incorporated into the current comprehensive area assessment regime as national indicator 157 (HM Government, 2008).

In 2003, the Government introduced the planning delivery grant, linking a large part of its allocation to the performance in meeting BVPI 109. This further increased the awareness of the target and the pressure to comply with the targets, although it has now been redefined as the planning and housing delivery grant, slightly reducing the emphasis on planning application time targets (Department of Communities and Local Government, 2008)

It can be seen, through the examination of the performance on these targets that local planning authorities have reacted to this enticement. In 2002/2003 83% of local planning authorities failed to meet the BVPI target relation to major planning applications: BVPI 109a (Audit Commission, 2002). In 2006/2007, on the other hand, 86.6% of authorities were meeting this target (Audit Commission, 2007). As previously discussed, however, it is necessary to consider the other impacts of this target achievement in addition to whether the practices put in place to achieve these performance improvements are sustainable in the long term.

Discussion surrounding the impacts of these targets on the practice of the local authorities is not limited to Development Control and academic coverage is predominant throughout the public sector. Alcock, when exploring Health Action Zones, describes the effects of targets and indicators in steering the monitoring and evaluation of programme activity towards inputs and outputs rather than outcomes (Alcock, 2004, 220).

Specifically, in the case of Development Control, Carmona acknowledges the perceived impacts of the targets as being frequently criticised as, ‘distorting the service by moving the emphasis and resources away from delivering quality outputs’ and that the indicators have, ‘revealed themselves to be largely blunt instruments with which to micro manage the planning process at the local scale’ (Carmona, 2003).

Specifically these consequences, in the case of Development Control targets included, for example, increase refusals and withdrawals of planning applications, increasing the number of appeals and causing authorities to fail to register applications. However, despite this debate continuing, reports produced by the Audit Commission, while acknowledging that these consequences could occur, continued to reject the idea that these practices were widespread. In 2005, in its annual review of the Planning Delivery Grant, it stated that, ‘there was no generalised evidence to suggest that the Planning Delivery Grant (PDG) has resulted in any unintended consequences’ (Office of the Deputy Prime Minister 2005, 7).

This rhetoric, which previously appeared to deny any widespread unintended consequences, reached a threshold in November 2008, and began to acknowledge the consequences of this targeted focus. A brief synopsis of these studies and reports follows.

THE KILLIAN PRETTY REVIEW AND 'PLANNING FOR HOMES'

In March 2008, the Government commissioned Killian and Pretty to investigate the planning process looking at ways to cut the red tape within the system. The review reported in December 2008. Concurrently the National Audit Office published a report investigating the measures taken by Government to increase the speed of decision making within the planning process.

At the end of 2008, the UK Government published the results of these two research projects: 'The Killian Pretty Review, Planning Applications, A faster and more responsive system' and the National Audit Office's 'Planning for Homes'.
The Killian Pretty review undertook a large scale consultation exercise. This included 169 formal responses to its 'Call for Solutions', 9 'stakeholder events and it commissioned three other studies: a 'review of information requirements for planning applications', 64 detailed case studies and a report on the 'availability of use and guidance on planning applications. These involved the participation of many stakeholders in the process ranging from local authorities, developers, academics and other advisors. The National Audit Office report (National Audit Office 2008) was conducted on a smaller scale but undertook detailed case study analysis as part of its investigation.
The Killian Pretty Report produced a total of 17 recommendations based around 5 key areas of concern: proportionality, process, engagement, culture and complexity.
These reports, while covering other issues, do appear to mark a threshold in the official rhetoric in relation to the impacts of targets in Development Control, and, with a range of case based evidence, they acknowledge that the unintended consequences of the target culture do impact on the delivery of a quality service, even in relation to the overall speed of development projects. Following this acknowledgement, the reports make recommendations to overcome the cultures of target meeting and to provide an overall increase in speed in the system. It is this breakaway from a single measure of speed, and the steps towards an overall system approach which is the intended focus of study of this work.
These recommendations are intended to be implemented by, and produce significant benefit for, a number of different stakeholders. For example, proposals to expand the range of developments which can take place without the need for planning permission must be acted upon through the legislative power of central government whereas an increase in the utilisation of electronic delivery of services and consultation requires cooperation between any number of stakeholders in the process. However, a vast majority of the recommendations require the involvement, and consequently the support of, local planning authorities. These local authorities are not, in themselves, located within a vacuum, or are, indeed a simple organisation, and, as such, any implementation of the proposals will involve a large variety of actors, both internal and external.
While research has been conducted into the existing situations, it would appear that it is a beneficial exercise study the ability of local planning authorities to react to change, taking the recommendations of these reports and exploring the practical implications and potential of their implementation. It is proposed that the Viable Systems Methods initially devised by Stafford Beer is a suitable tool in undertaking this work.

SYSTEMS PRACTICE

'The central purpose of systems analysis is to help public and private decision and policymakers to ameliorate the problems and manage the public policy issues that they face. It does this by improving the basis for their judgement by generating information and marshalling evidence bearing on their problems… focusing on problems arising from interactions among elements of society, enterprises and the environment' (Miser & Quade, 1985,2)
From this general definition it would seem that systems practice is appropriate to the area of development control as an essential consideration of the techniques is the context in which problems are based and the interactions which take place amongst both actors within the system and between the system and its environment.

The development control process lies within an inherently political and economic context which will continually influence the implementation of proposals. As such, it would be difficult to examine the potential of the recommendations without taking this context into account. To take what is a current issue, any policies for increasing the speed at which homes are being constructed cannot be realistically considered without taking full account of the existing economic climate. However, the aim of the proposal cannot be immediately focused on the short term, and must remain valid following a change in economic circumstances.

Within the domain of systems thinking, there exists a wide range of methods and techniques which can be used to explore these interactions, responses and consequences. A simplification of these concepts could describe these as follows. Hard Systems stems from a positivist, reductionist and quantitative examination of situations, looks at how to control the environment. Soft Systems looks at the situation within its environment and Viable systems which that looks at how a system is able to adjust to its environment. These three elements will be briefly discussed below.

Hard Systems Methodology was predominantly development within post world war II industry. The aim of practitioners is to manage the system and its environment through a process of investigation and analysis using tools such as linear problem solving to identify individual problems and their solutions. However, it is not a solely quantitative tool as the analyst will always need to remain aware of the non quantifiable constraints which will set the political and value boundaries on the final decision (Bell and Chapman, 2004). Key elements of the Hard Systems Methodology include a clear definition of the problem and its context, the generation of different means of meeting these objectives, the formulation of performance measures, the evaluation of routes through modelling techniques and, finally, the selection of the appropriate routes.

The Soft Systems methodology grew out of the criticism of hard systems techniques and their reductionist approach: the methodology of systems engineering does not work when applied to messy, ill-structured, real-world problems (Flood & Jackson, 1991, 68). It extends the boundaries of a 'problem situation' from a clearly defined objective into the context in which the problem may lie. The intention of a soft systems practitioner is to learn about the situation that they are exploring, take action based on that knowledge and then once again examine the situation and act if necessary. As such it is a form of Action Research.

Viable Systems analysis, which stems from the field of Cybernetics, was predominantly developed through the work of Stafford Beer in a series of books and articles (commencing with Beer, 1959), and which was also put into practice in a range of situations including the Chilean Economic System. Beer, like other systems practitioners, believed that a key component of any system is the environment in which it is situated. While the soft systems methodology takes account of this in its works and hard systems seeks to control it, viable systems theory believes that the structure of the system must within itself be able to adjust as the environment changes.

Choice of Viable Systems

The Development Control System and the decisions made and subsequent developments are set in a wide context. The motivation for undertaking this research stems from the predominantly reductionist approach to the problem of speed within development control (the targets concerning the time taken to determine applications) and its unintended consequences and their lack of account of its other impacts. As such, it would not seem appropriate to propose the use of a hard systems methodology which continues with a similar philosophy and toolbox. Meanwhile, the soft systems methodology, action research approach, which

may be appropriate on a case by case basis, would prove difficult to fully, and successfully implement, with a local government context with its varied environmental influences (such as local politics and economic influences).
As a result the use of Viable Systems which looks at the decisions, actions and interactions and the real world functioning of systems, would seem to be appropriate to the complex area of Development Control which, as has been seen, cannot be examined without consideration of the context in which it lies. The Development Control, and the Planning System, are embedded within the social, economic and political structure of the country and should not be considered in isolation from these.
As such, it is considered that the Viable Systems Methodology will provide a coherent means of assessing the potential for the implementation of the proposals within Local Authorities while not disregarding the context and other impacts which may result. This analysis will identify the potential for the benefits of the proposals to be put in place in addition to any possible barriers to the successful implementation of the ideas.

VIABLE SYSTEMS

The fundamental concepts of the theory relate to variety, autonomy and power. These concepts are briefly discussed below. As previously described, a key element of a Viable system is the ability of the system to adjust when changes occur in its environment. The ability of any system to adapt to this change can be investigated through the examination of 3 ideas:

- Recursive Systems
- Trust, Autonomy and Power
- Variety

Recursive Systems

The theory advocates the idea that each viable system is itself contained within a viable system and will itself contain viable systems and so forth. The Development Control system cannot be isolated as an individual unit, it is one element of, and entwined within, the planning service of the local authority and the unit of the Local Authority as a whole. Indeed, additionally, the authority itself lies within, for example, the wider system of Local Government, which lies within the overall system of UK Governance.

This recursive nature of any organisation is discussed within Viable Systems theory and, once a system of interest has been defined, a number of 'Internal systems' are identified and analysed. The can briefly be described as the Operations, Stability, Cohesion, Planning and Policy Units. These different functioning systems must work coherently in order for the system to be viable. These systems can briefly be described as:

- Operations: producing the systems aims
- Management of Stability: responsible for looking inside the organisation, resolving conflicts between the units
- Management of Cohesion: responsible for looking inside the organisation maximising the cooperation between the units
- Management of Planning: responsible for looking outside the organisation, making long term plans and identifying the future resources
- Management of Policy: identifying and developing the overall policy for the organisation as a whole

Trust, Autonomy and Power

In order for a system to be viable, the above 'internal systems' must be able to work efficiently together. This needs to be achieved through the ability of each system to be able to work to meet the overall aim of the system, while leaving the others to produce their own outputs, without undue interference. In order for this trust and autonomy to be achieved, it is important that the overall system has a clear identity (or aim). This can be found through the construction of an identity statement. In searching for this identity, it may be possible to see where conflicts lie, and consequentially, weaknesses appear in the system. Espejo et al (1999) identify different factors which could be taken into account when constructing an Identity Statement.

- What is produced by the organisation
- What needs are being satisfied by what is produced
- What time factors influence the production
- What is the size and location of the organisation
- What is the relationship with the environment and the products of the organisation
- What organisations are related
- What are the economic variables
- What are the financial variables

When these factors are analysed within the different levels of a system, there needs to be agreement amongst the levels of recursion. If disagreements arise, this would indicate that the viability of the system may be at risk and therefore attention should be given to this area.

This reductionist approach may have also led to the lack of trust and autonomy within Development Control services. For example, with the focus on achieving targets, it would appear that there have been conflicts between the aims of those within Development Control, and those within the management elements of the councils. The pressure on the speed of decision making has been acknowledged to impact on the quality of decisions, and therefore, subsequently, on the quality of developments. Therefore, it appears, that there was a conflict between the aims of the subsystems: the operations, Development Control, could be said to be operating to produce good quality development while the audit and policy systems were looking to produce good performance statistics, to boost the status of the organisation and the income stream. The Viable Systems method believes that if this conflict is appearing the system as a whole is, in all likelihood, inherently unstable.

Variety

The methodology draws on Ashby's Law of Requisite Variety (Ashby, 1956) which is stated by Beer as, 'only variety can absorb variety' (Beer, 2002). The theory of the methodology believes that this variety can be achieved through a balance between the autonomy and the power of 'internal systems', as discussed above, within organisations.

Given its location within society, it is important that the planning system is able to cope with changing environments. To use a highly topical example, the current economic climate creates conditions in which Authorities will be experiencing change, both in changes to funding, through Government funds and fee income, and through pressures on staffing levels. However, as the economy picks up, it will be important to have a supply of skilled and experienced staff members to deal with an expected increase in workload.

In the context of this study, the ability of an authority to implement the recommendations put forward by the reviews, will, ultimately come down to the Authority's ability to cope with change, therefore variety and it is important to identify what barriers, or even good practice, exist. In Viable Systems theory, this ability primarily depends on the existence of, and the trust, power and autonomy between, the 'internal systems' of the organisation.

CONCLUSION

While this paper has provided just a brief overview of the issues, recent developments and the proposed methodology to study the situation, it is hoped that it has provided a useful introduction to this area of research in an important aspect of the English planning system. The most recent recommendations relating to the successful increase in the speed of the Development Control system need to be implemented by a variety of stakeholders. Local Authorities are, inevitably, a key stakeholder in this implementation but they cannot be considered independently of the economic, social and political world in which they lie. In order for the proposals to be successful, this environment must be taken into account.

As a result the use of Viable Systems which looks at the decisions, actions and interactions and the real world functioning of systems, would seem to be appropriate to the complex area of Development Control which, as has been seen, cannot be examined without consideration of the context in which it lies.

The development control, and the planning systems, are embedded within the social, economic and political structure of the country and should not be considered in isolation from these. As such, it is considered that the Viable Systems Methodology will provide a coherent means of assessing the potential for the implementation of the proposals within local authorities while not disregarding the context and other impacts which may result.

It is considered that the Viable Systems methodology will provide a solid basis on which to base a study on the implementation and the possible success of the proposals put forward to improve the delivery of Development Control within England. This analysis will identify the potential for the benefits of the proposals to be put in place in addition to any possible barriers to the successful implementation of the ideas.

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A CRITICAL ANALYSIS OF THE CONSTRUCTION SKILLS CERTIFICATION SCHEME

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The Construction Skills Certification Scheme (CSCS) is a card scheme that allows individuals to prove they are capable of doing their job and that they will do it safely. This research evaluates the original aims of the scheme and addresses how the scheme is viewed in the construction industry. With a critical review of literature, questionnaires and interviews triangulation has been enforced, to check the validity of the data. The results show that the construction industry view CSCS as a health and safety scheme only and many do not acknowledge that it is a competency based scheme. Critically, the research shows that the scheme has support from contractors, clients, unions and the government, and has been positively accepted by the industry and looks likely to grow from strength to strength.

Keywords: Competency, CSCS, Health and Safety

INTRODUCTION

Rationale for the Research

The Construction Skills Certification Scheme (CSCS) was introduced by the Construction Industry Training Board (CITB) in 1995 with the aim to "register every competent construction operative within the UK not currently on a skills registration scheme" (HSE, 2003). CSCS was "designed to raise standards and weed out the cowboys by making it easy to check a worker's qualifications" (Construction News, 1995, p. 1) In addition to identifying skills levels, the CSCS card "also provides evidence that the holder has undergone health and safety training or testing" (Constructing Excellence, 2005). "Operatives receive an individual registration card (similar to a credit card), which shows they have the required skills and competencies and provides evidence that the holder has undergone health and safety awareness training or testing" (Office of Government Commerce, 2003)

Originally to obtain the CSCS card the attendance to a CSCS training course was required. This condition was abandoned in April 2000 due to "the criticism of larger employers who felt that formal health and safety training would duplicate their own" (HSE, 2003) Thus in April 2000 the health and safety test was introduced.

CSCS Secretary General, Bill Jenkins has been quoted as commenting "More and more clients and employers, large and small, are demanding that operatives hold CSCS cards because they understand it means workers are competent in the requisite skills and have up-to-date health and safety awareness." (CITB, 2005). In 2003 CSCS were awarded with the Working Well Together (WWT) Special Award for 2003 where the judges commented

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"CSCS has risen to the challenge of developing a single competence card for health and safety that is recognised across the construction industry" (HSC, 2003).

Health and Safety

"The construction industry has a world reputation for the quality of its work but it remains one of the most dangerous in Britain" (Hughes & Ferrett, 2007, p. 1). This being so "Construction management has a perpetual and unswerving challenge to ensure a safe and healthy working environment" (Griffith & Howarth, 2001, p. 3).

Competence

Competent is defined as "having the necessary ability or knowledge to do something successfully" (The Concise Oxford Dictionary, 1999).

"An essential part of any effective health and safety management system is to ensure that employees are competent...competence is not a static attribute, but needs to be maintained to remove the detrimental effects of lack of practise and changing circumstances" (Pearce, 2007). In the Management of Health and Safety at Work Regulations 1999, reg. 7(5) states, "a person shall be regarded as competent...where he has sufficient training and experience or knowledge" (HSE, 1999). Three aspects to competence can be described as:

- The knowledge of the subject
- The experience to apply that knowledge correctly
- The personal qualities to undertake their functions effectively

Therefore theory would suggest that schemes which show competence are highly regarded, and this is where CSCS comes in, "CSCS aims to register every competent construction operative within the UK not currently on a skills registration scheme" (HSE, 2003).

What is the Construction Skills Certification Scheme?

"CSCS is owned by CSCS limited, a company controlled by a management board whose members are from The Construction Confederation of Master Builders, GMB Trade Union, National Specialist Contractors Council, Transport and General Workers Union and Union of Construction Allied Trades and Technicians." (Broughton, 2004b)

The Construction Skills Certification Scheme is a card scheme which allows individuals to prove that they are capable of doing their job and that they will carry it out safely. The CSCS card "carries your name and photograph, says that you have passed a Health and Safety Test, and lists your qualifications" (CITB-Construction Skills).

"Quality up, accidents down and cowboys out were the main objectives for the formation of the Construction Skills Certification Scheme (CSCS) when it was launched in 1995" (CSCS, Your Quick Guide to CSCS, 2007). Stephen Goodchild, an estate manager for the East Gloucester NHS Trust has claimed "the industry is full of cowboys. Clients need hard evidence of qualifications" (Hampton, 2000).

CSCS cards are now related to NVQ's and as such "There have been some changes to the CSCS card names to bring the cards in line with the NVQ names...Each card is distinguished

by its colour, which related to the equivalent level NVQ" (MCG, 2006a). Also a few previous record schemes have now become affiliated to CSCS and therefore show the CSCS logo on them for example "Construction Industry Scaffolders Record Scheme...Demolition Operatives Scheme...Engineering Services" (MCG, 2006a).

Aims and Objectives

Some of the aims of CSCS were to "encourage construction and their customers to use skilled workers" and "raise standards of health and safety to reduce risks and accidents throughout the industry" (CSCS, 2007a). Another benefit of the scheme, if successful in cutting accidents down it will have financial benefits to the industry as "Accidents cost the construction industry millions of pounds annually" (Griffith & Howarth, 2001, p. 27).

A report states that the benefits of the scheme "for the individual are recognition for skills, competence and qualification" and "promotion of greater health and safety and personal training awareness" (Mackenzie, Kilpatrick, & Akintoye, 2000, p. 854), whilst for the employer the benefits include "identification and recruitment of the right people, improved standards of health and safety awareness, and raising quality standards" (Mackenzie, Kilpatrick, & Akintoye, 2000, p. 854).

Growing in Popularity

In 2007 "significant progress has been made...on average, 20,000 new cards per month are now issued and in May 2007 the millionth CSCS card was presented" (CSCS, 2008a). The number of cards issued to date on 11th March 2008 was 1,223,264. Key developments for CSCS include "the introduction of the Professional Membership Mapped Route" and "the introduction of the Professional Qualified Persons Card" (CSCS, 2008a). Other factors include "the new CDM Regulations which, for the first time, stipulated that checks should be made on the competency and health and safety awareness of contractors" (CSCS, 2008a).

Contractors in Support

Many Principle Contractors are taking the scheme seriously and publicly showing their support: "All workers on BAA sites must apply for a CSCS card relevant to their job within 28 days" (CSCS). Gren Tipper of BAA states "Safety is our number one priority and we look for CSCS cards as a demonstration of workers' competence and proof that they are aware of their health and safety responsibilities" (CSCS). UK construction company Frank Haslam Milan (FHM) "has hit its target of a zero accident rate through training and awareness" (Pollitt, 2006, p. 23). Irene Liddle, HR manager, said of their employees "the vast majority attaining CSCS accreditation within six months of joining...we also identified a number of site operatives who were hindered by poor basic skills. To remedy this, these employees are to be put through training in literacy and numeracy" (Pollitt, 2006). "More than 80 percent of the FHm workforce now has CSCS accreditation" (Pollitt, 2006).

Clients in Support

"It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees" (HSE, The Health and Safety at Work Act, etc 1974, 1974, p. 3). Hughes and Ferrett suggest that

"The construction client who commissions the work is a very important agent in the drive for improved health and safety standards. He should insist on good evidence of the health and safety record and performance of a contractor at the tendering stage, ensure that health and

safety standards are being met on site. He should also require that all the people working on site are properly trained for their particular job."
(Hughes & Ferrett, 2007, p. 1)
Holt agrees with this point calling the client "a key figure in the construction safety management process, as the instigator of the work and the source of funds" (Holt, 2005, p. 40).
Therefore it comes as no surprise that The Construction Client's Group (CCG) is "increasing pressure on clients to ensure workers are CSCS qualified by incorporating the requirement into its clients' charter" (Building, 2004a). The CCG is also "recommending that clients include a CSCS clause in their procurement contracts" (Building, 2004a). CSCS are "also seeing an increase in the numbers of clients who are specifying CSCS cards as part of their pre-qualification criteria" (CSCS, 2008a). The benefits of CSCS are "intended to give clients greater confidence when awarding contracts" (Mackenzie, Kilpatrick, & Akintoye, 2000, p. 854).

Unions in Support
It is clear to see unions have backed the scheme, with National Specialist Contractors Council (NSCC) "offering its Specialist Contractors £100 for every CSCS Skilled Worker card they have achieved via NVQ level 2 or above since September 2005" (NSCC, 2007).
The MCG, "established in 1996 to represent the interests of large contractors in the UK" (MCG), have put a lot of effort in ensuring a fully qualified workforce. MCG have claimed they are "committed to operating construction sites that provide a working environment, which is both safe and free from health hazards" (MCG, 2005). In 2004 an audit showed that "almost two thirds of the workers surveyed...held Construction Skills Certification Cards" (MCG, 2004). This was despite setting a "target date of the end of 2003 to achieve a fully qualified workforce" (MCG, 2004). The press release gave no reasons or excuses to why this target had not been reached. In a press release on 11th July 2006 they announced "measures to complete the initiative to employ a fully qualified workforce on all their construction sites" (MCG, 2006c). The press release stated that from 1 October 2006 all construction trade "must either have an appropriate skills card or be taking firm steps to obtain one through registration with Skills Direct" (MCG, 2006c). The Skills Direct Service "is the quick and easy way to get qualified and get a card" (CITB-Construction Skills) from CSCS Ltd and CITB-Construction Skills. "MCG prefer to have a single universal registration scheme and will continue to work with CSCS towards this goal either through affiliations or by creation of new occupational categories" (MCG, 2006a) The MCG Press Release continues:
"With effect from 1 January 2007, and subject to Skills Direct being able to cope with the consequent extra demand for CSCS cards, everybody working on an MCG site must have an appropriate skills card" (MCG, 2006c).
As promised, on 2nd October 2006 MCG produced a press release that warned "from today...no-one will be allowed to work on MCG sites without having the appropriate CSCS card or having registered with Skills Direct as a first step towards obtaining one" (MCG, 2006b). An audit of MCG sites was carried out on 1st February 2007 involving "in excess of 600 sites across the UK and showed that 86.1 per cent of the people working on those sites on that day held an appropriate skills card" (MCG, 2007). John Spanswick said the result was excellent continuing "because of the constant churn in the industry's workforce – from site to site and company to company – achieving full compliance will always be a challenge" (MCG, 2007).

CSCS – Success or Failure

Despite CSCS getting off to "a flying start" (D'Arcy, 1995) the Major Contractors' Group (MCG) failed to reach its "target of 100% compliance by 31 December 2003" (HSE, 2003). Yet in spite of this the HSE have argued that "major advances contributing to raising on-site standards will have been made" (HSE, 2003). In a report commissioned by the CSCS board, Bob Bilborough "does not seem to believe the scheme is being taken forward, and his recommendation is that the CSCS board be given a proper administrative identity" (Broughton, 2004b). The report, written in 2004, nearly 10 years after the introduction of the scheme, points out "that at the current rate it will take the industry up to 30 years to become fully qualified" (Broughton, 2004b). A critic of the report claims "Bilborough has identified its [CSCS] problems and established what the solutions should be, but has failed to identify how they should be arrived at" (Broughton, 2004b). In 2004 the CITB management were being criticised "by unions over the fact that only 8.5% of workers operating in the "biblical" trades of carpentry, plastering, bricklaying and painting hold CSCS cards" (Building, 2004b). One senior union source said "CSCS was set up for craft workers...however, 10 years on and the scheme only has a small percentage of these workers on board. What the hell's been going on?" (Building, 2004b).

Popularity

As for the future, the NSCC appear to believe in CSCS, "Health and Safety is integral to the success of any project" (NSCC) and is one of the six key areas vital to the 2012 Olympic and Paralympic Games with the 2012 Construction Commitments claim that "All professional and site staff" [involved with the Games 2012] "will hold Construction Skills Certification Scheme (CSCS) cards or equivalent" (NSCC).

Simon Brown of LHT claims that CSCS is "an important element of our overall health and safety management system" (Clay) Gren Tipper at BAA stresses the CSCS cards are "an excellent starting point as they give a client an assurance of good standard of workmanship when dealing with companies they are not familiar with" (Hampton, 2000). This is supported by a survey undertaken by Mackenzie et al which "demonstrates that construction employers support" CSCS (Mackenzie, Kilpatrick, & Akintoye, 2000, p. 853).

Bilborough's report, commissioned by CSCS concludes that "the top priority should be a campaign targeted at persuading regional and local government to use firms with CSCS accredited workforces." (Broughton, 2004b). Liverpool Housing Trust (LHT), "which owns and manages over 26,000 homes across Merseyside" (Clay) was recognised as "making a significant contribution to the construction industry's commitment to CSCS when divisional director (Asset Management) Simon Brown was presented with a gold certificate by CSCS chief executive Brian Adams. CSCS gold certificates are awarded to organisations when more than 75% of their onsite workers hold CSCS cards." (Clay)

CSCS is also becoming prominent in the health care sector. "A recent survey conducted by Procure21...revealed that all of its Principal Supply Chain Partners (PSCP's) are actively supporting the Construction Skills Certification Scheme (CSCS) and that, on average, more than 80% of their people hold CSCS cards" (CSCS, 2008b). Procure21 is the "NHS and Development of Health's construction partnering program" whose objective "is to achieve excellence in NHS construction" (CSCS, 2008b).

However much support CSCS has achieved there are still problems associated with the scheme, "Bilborough's report suggests "the problems in the UK's system of vocational training is one of the main barriers to achieving a qualified and cardholding workforce". He calls for a full review of construction training qualifications, with particular focus on integrating older and foreign workers" (Broughton, 2004b). When reading forums on health and safety websites one topic that is sometimes discussed is if CSCS is a profit making

scheme. In 2004 CSCS cards found themselves at the centre of a £700,000 cash row. "Figures were presented at the meeting that suggested that the scheme was £700,000 in the black...CITB wants to use it to supplement its training grants and the CSCS want it for its own purposes" (Broughton, 2004a).

Expansion

Mackenzie et al found that despite the slow penetration of CSCS "the opinions of senior management within the UK construction industry indicated that there is growing support for the scheme" (Mackenzie, Kilpatrick, & Akintoye, 2000, p. 860). "Brickwork contractor Landmark Brickwork is docking £10 a day from workers that don't hold CSCS skills cards, in what it claims is a move encourage non-card holding workers to join the CSCS scheme" (Construction Manager, 2008). But this "last-ditch attempt to get the remainder [of the workforce] on the scheme" (Gerrard, 2008, p. 1) was criticised by UCATT London regional secretary Jerry Swain who said "It is completely out of order and purely designed to increase their profit. It's not as if they are offering as extra £10 to people who have CSCS cards" (Gerrard, 2008, p. 1).

CSCS appear to be continuing to expand. In 2008, CSCS intend to launch the Smartcard "which will allow clients and contractors to integrate the information in their own computer systems with CSCS information as well as occupational health data from Constructing Better Health" (CSCS, 2008a).

ConstructionSkills "launched a new, integrated health and safety training programme called Site Safety Plus...which is described as a "lifelong learning plan" for health and safety" (health and safety at work, 2007a, p. 3). Kevin Fear, head of health and safety at ConstructionSkills, claims "it is worrying that large numbers of companies are providing insufficient or inadequate health and safety training" (health and safety at work, 2007a, p. 3).

METHODOLOGY

This research utilised two sorts of primary data, namely questionnaires and interviews, thus gaining both quantitative and qualitative research. Combining these methods aid in Triangulation, i.e. they produce a complete picture, and aid as a check of accuracy of the conclusions reached by each.

A structured questionnaire was produced for this research, mainly of a 'closed' format with only two 'open' questions. The questionnaire was distributed via both post and email, to 120 people that work within the construction industry. To make the research fair and free from bias it was the researcher's aim to get as representative sample of the industry as possible. This meant sending questionnaires to both contractors and professional practises, asking them to distribute the questionnaires to both office based staff and site based staff. Participants were given 3 weeks to complete the questionnaire and after 3 weeks a follow-up letter/email was distributed to those that had not completed it. This method allowed for the return of a remarkable 86 completed questionnaires, thus the research gained a large sample of results for analysis. Of the 86 that answered, 79 were male and 9 were female.

The research was further enhanced by the use of structured interviews. Health and Safety managers were the sample for the interviews as they are often heavily involved with the scheme. Four interviews took place, all managers from different construction companies. Structured interviews were utilised to provide more accurate answers and they allowed for a comparison analysis.

ANALYSIS

The research showed that there is overwhelming support for CSCS, with many respondents feeling positively towards the scheme rather than negative. However what did emerge was that those that felt negatively about the scheme were the tradesmen, the job sector that spends the most time out on site, the sector it could be argued, that the scheme is most relevant to. One of the health and safety managers interviewed supported this argument by explaining that when he first heard about the scheme he was not a health and safety manager but an operative on site, and when in that position his opinion of the scheme was very negative, which has since changed to positive. However there was no link between whether a participant holds a CSCS card or not and if they think positively or negatively about the scheme.

CSCS has many objectives, however the objective that those in the construction industry think is of the most importance is to improve health and safety awareness on site, followed by reducing accidents on site. The research confirmed that most primarily associate the scheme with health and safety, when in fact it is a competence scheme in which health and safety is only one part of it. The research suggests that the scheme should try to educate the industry, making them more aware of all its objectives, for example the objective that they are trying to provide certification for UK workers that could be accepted in Europe.

Of the 86 questionnaire participants only 62% of the participants work for a company that have made CSCS mandatory. Considering CSCS was introduced 13 years ago with a view of making it compulsory this statistic would appear on the low side. However this did raise the question of whether 100% compliance could ever actually be achieved, with such factors as the large migration into/out of the construction industry, and also the less traditional jobs within the industry.

Further findings showed that there is much agreement in the industry that holding a CSCS card improves their employability and also that the scheme should be mandatory in the workforce. However there were mixed feelings with regard to if the scheme is a money making scheme, or if the card is of any benefit to their career.

The health and safety test that forms part of the process to gaining a CSCS card costs £17.50 to sit, and the actual card itself costs £25. Overall it appears that the industry feel the cost is reasonable, however some are claiming the costs are too high. Further investigation highlighted that the results provide some evidence to support the claim that whether a participant thinks positively or negatively may effect if they think the card and test costs too much, too little or just right. Overall the results suggest that CSCS have got the right cost for the scheme in place.

There are two main reasons why people have obtained a CSCS card, namely because they worked on a site where it was mandatory or because their company made them.

Often when the subject of CSCS is discussed within the construction industry, more often than not comments are made regarding the simplicity of the test. The results from the questionnaire showed that only 5% of participants failed the test first time, but all passed on their second take. This shows a very high pass rate, showing almost how difficult the test is to fail. Evidently the research found that most of the participants found the test easy, however a majority would not use more challenging questions but suggest the test should stay as it is. In addition to this the general consensus is that the new scheme of having a health and safety touch screen test is preferred to the requirement to attend a training course which the test replaced. Reasons include the time and money it cost the firms allowing an employee time off work to attend the training course.

The research looked not only at the uptake of the scheme but also at the maintenance of the scheme. It is one thing for individuals to be getting a CSCS card, but also of importance is

whether they have to show their card. The questionnaire asked respondents how many times they have been asked to show their CSCS card, and 32% claimed they have never been asked to show their card, and a further 18% have only been asked once. If the scheme is growing in popularity and importance as they would lead us to believe then one would expect this figure to be higher.

With media being so influential the question of how CSCS is portrayed was one that had to be discussed. Interestingly a majority of people claimed not to have seen anything regarding CSCS in the media, but of those that have, most claimed it was positive. However one of the interviewees claimed that he had not seen CSCS in the press, however after some thought recalled a story regarding forged CSCS cards being sold, therefore a negative story. It would appear that the CSCS scheme is not at the forefront of the media and goes unnoticed by many people in the industry.

Many believe that CSCS will have a positive future. Ideas of what will happen to the scheme include; the scheme becoming mandatory, the scheme will expand improving health and safety and it will produce competent workers. However there are some who believe that the scheme will soon have lower take up rates, that it is worthless and needs improving, and will eventually be replaced by another scheme. There were also hints that the whole scheme is just about making money. Some believe that the fundamentals of the scheme should remain, however the format and difficulty of the test should be reviewed. One interviewee suggests it will become a minimum requirement to get on site and will be added to the saying "no hat, no boots, no hi-viz no CSCS". Interestingly, the results from the questionnaires did show strong evidence to suggest that there is a link between how participants view the scheme now and what they think the future holds for the scheme. For example, if they feel positively about the scheme now they also think the scheme has a positive future.

The topic of enforcement appears to turn into a good debate; however it is a question that does not have a simple answer. There are suggestions of the government, main contractor, client, unions or even professional bodies. Legislation was also suggested, however that would probably be over the top at this time.

The most popular area for suggested changes to the scheme was the assessment. The suggestions included; more frequent testing, tests being more practically based and perhaps include a practical health and safety assessment. Another area recommended for change is the administration side of the scheme, with complaints of the length of time it takes to issue cards, re-new cards etc.

CONCLUSIONS

The original aim of CSCS was "register every competent construction operative within the UK not currently on a skills registration scheme" (HSE, 2003). Since then CSCS has been the main skills card and many are working towards making CSCS the single standard competency. Research has shown that people within the industry think that the main aims of the scheme are health and safety related: raising health and safety awareness and reducing accidents and risks on site. Although health and safety is a big part of the scheme, likewise is the competence part of the scheme, which appears to be overlooked.

When investigating the secondary research there is much information on how contractors and clients are endeavouring to make the CSCS compulsory for their place of work. Contractors, large and small, are boasting that they have achieved a 100% carded workforce or are well on the way to making it mandatory. Unions too are persisting with making CSCS mandatory on all their sites. Furthermore it has been extremely difficult to find any secondary research that suggests not making the scheme mandatory, thus conclusions can only be made in support of this step. The primary data would also suggest that most people are not offended by the idea,

most do not disagree with the step therefore there are no substantial arguments to support not making the scheme mandatory. When asked what they thought would happen in the future to the scheme many claimed that it would be made mandatory.

The subject of who should enforce the scheme has proven to be a difficult one. This research has produced no firm conclusions and no patterns have arisen, a reason being there is support for various contenders. Contractors have proven to be a popular choice, and yes they are responsible for ensuring all their staff owns a CSCS card but should there be someone that polices the contractors? The government are another popular choice, but one interviewee claimed that legislation of CSCS would be over the top at this time. Presently there is no legislation in place, but the government have produced guidance to staff on the CSCS scheme and advice on the implication of working towards a single standard of competence. Following government in popularity for the job of enforcing CSCS are the clients, as they could potentially stop anyone from working on their sites without a CSCS card. The Construction Client's Group (CCG) have incorporated the requirement for CSCS qualified into its clients' charter and recommend that clients include a CSCS clause in their procurement contracts.

In May 2007 the millionth CSCS card was issued, and CSCS claimed that popularity was growing with an average of 20,000 cards being issued each month. By 11th March 2008 1,223,264 cards were issued. However, there is still not a fully carded workforce across the industry, and there is debate as to if 100% can ever actually be reached. Deadlines for a fully carded workforce are continually pushed back with no reasons or explanations. One example of this is the MCG who are extremely keen to see all their sites fully carded but are still not quite there. One of the interviewee's worked for a company that belong to the MCG and although he stated that his company were working towards a fully carded workforce he could not give an estimated date, or any reasons as to why they have waited so long.

The health and safety test became part of the CSCS process in 2000, and now passing the test is crucial to obtaining a CSCS card. Interestingly out of all 86 participants that responded to the questionnaire only 5% failed the test on their first attempt but all passed on their second, therefore there is high evidence that the test is on the easy side. This statistic, and the thoughts expressed elsewhere in the questionnaires and interviews all suggest that the test is easy, however many think that the test should stay as it is and should not be made harder. In addition to this, the health and safety managers appeared to be in support of individuals taking the test as many times until they passed their test.

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HEALTH AND SAFETY FILES

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A Health and Safety file is a compulsory document which needs to be included with the construction of any commercial property within the UK, since the implementation of the Construction (Design & Management) Regulations 1994 (CDM). The purpose of the file is to provide health and safety documentation to any individual who will be operating equipment within or working on elements of the commercial property after its construction. The file's requirements were then further elaborated by the Construction (Design &Management) Regulations 2007 (CDM 2007). Research was undertaken with the aims of reviewing the current practices surrounding the use of the Health and Safety file, and determining the adequacy of the file in terms of end user application. Closed-ended questions were utilised in both interviews and questionnaires, which were conducted with Principal contractors, CDM co-ordinators and commercial property users. Qualitative data was also acquired through the inclusion of open-ended questions in both research methods, and through an observed case study within a commercial property. Legally, the Health and Safety file has to be handed to the client upon completion of the property. Although the end user then has no legal right to own a copy of the file, nor be informed of its existence, the results showed that managers of commercial buildings were all given a copy of the file, and they generally believed the file to be highly effective at fulfilling its purpose. However the effectiveness and knowledge of the file decreased within the hierarchy of commercial property employees. Research has shown that the files are produced to a high standard when issued to the commercial property, but the contents and purpose of the file is not communicated effectively within the organisational culture. It was also discovered that 12% of Quantity Surveyors were unaware of the correct purpose of the Health and Safety file, and over 76% of QS'S surveyed were unclear as to their legal obligations under the CDM Regulations (2007).

Keywords: documentation, health and safety,information management

INTRODUCTION

By workforce, construction is the UK's largest industry with over "2.2 million people" (HSE 2008) and according to the Egan report 'Rethinking construction', *"the health and safety record of construction is the second worst of any industry"* (Egan, 1998, p25). The HSE also report *"in the last 25 years, over 2,800 people have died from injuries they received as a result of construction work"* (HSE 2008). Even though the numbers of fatal accidents in the construction industry remain high, Griffith and Howarth (2000, p4) report *"the level of awareness and recognition for health and safety within the construction industry is increasing"*.

In an effort to reduce both the number of fatal injuries to workers, and the rate of major and minor injuries, legislation has been introduced with the aim of reducing accident prevalence in numerous ways. The Construction (Design and Management) Regulations were first

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introduced in 2004, and revised in 2007, in an attempt to *"integrate health and safety into the management of the project and to encourage everyone involved to work together"* (CDM 2007 ACOP p1). The 2007 revisions sought to provide greater clarity on the responsibilities of the individuals obliged to complete the file.

The introduction of the Health and Safety file was an attempt to reduce the prevalence of dangerous accidents occurring, as Etchells (1997, p52) states *"the health and safety file will endorse the commitment of the construction industry to hand-over buildings that are safe to use for all repairers and refurbishment contractors".* The purpose of the file, according to Joyston-Bechal and Grice (2004, p31) is *"to provide information needed during the future construction work on the site".* The research was aimed towards discovering if the individuals concerned were fully aware of their legal responsibilities and, how effective those legal responsibilities are in practice. The approach taken in the research was important as it gauged the opinion of the file from all those concerned with its existence. The conclusions drawn from the research aims and objectives helped lead to a greater understanding of commercial building users and the construction industries perception and knowledge of Health and Safety files.

RESEARCH METHODOLOGY

Walliman (2004, p153) described primary data as *"as near to the truth as we can get about things and events".* In an effort to gain primary data, questionnaires, case studies and interviews were utilised as data collection methods.

PILOT STUDY

The questionnaires were first issued during a pilot study, which is described by Moser and Kalton (1983, p48) as *"a small-scale replica of the main survey".* It was decided that a pilot study should be used as Bell (1996, p84) states that it is like *"getting the bugs out of the instrument so…subjects in your main study will experience no difficulties in completing it."* The study consisted of administering 30 questionnaires to the users of a single commercial building which helped determine the wording of the main research questionnaire, as Jowell & Hornville (1978, p51) commented that piloting work is *"extremely useful in refining the wording, ordering, layout, filtering and so on".*

MAIN STUDY

For the main research study 100 questionnaires were delivered to 10 different commercial buildings, 50 questionnaires to 6 different main contractors and 50 to CDM co-ordinators. This was in an effort to add validity to the research as Jowell & Hornville (1978, p61) says *"The larger the sample, the smaller the amount of sampling error to be expected".* The aim was to discover participant views and knowledge of the Health and Safety file, and how these views differed under comparison.

SAMPLING TECHNIQUES

Simple random sampling is where *"every subject or unit has an equal chance of being selected"* (Fink, 2005, p85) and was used to select all participants for the questionnaires in an effort to reduce bias, as Moser and Kalton (1971, p82) claim simple random sampling *"is an*

essential part of the protection against selection bias". Bias in itself is an undesirable influence as it would manipulate the results in one particular direction based on unfair factors, such as personal opinions and accidental exclusion of particular working groups, therefore an attempt was made to reduce bias as much as possible.

Convenience sampling is *"using what is immediately available"* Walliman (2004, p163) and was used inadvertently when questionnaires were issued to commercial buildings, as they were delivered on a weekend morning and collected within 8 hours, all staff not present that day were not consulted as to their opinions.

Upon delivery of the questionnaires to participants, the snowball technique was implemented, where *"one observed subject passes the researcher onto another"* (Sapsford and Jupp, 2006, p80). One advantage of this was that a *"reduction in effort was required to obtain a specific sample size…"* (Barnett, 2002, p192). However the non-randomness associated with the snowball technique could have crept in the study, with the possibility of the questionnaire being passed only amongst friends, who all share similar knowledge and experiences.

They were distributed via personal delivery to the commercial buildings, and via email to Principal contractors and CDM co-ordinators. This imposed generalisation limitations on the conclusions drawn, as the personal delivery only covered the Sheffield area, therefore the results could not be generalised on a national scale, and are only applicable to the Sheffield region. However this method was selected above postal delivery as Bell (2007, p148) comments *"postal surveys are expensive and response rates are generally low"*.

The questionnaires maximised the use of closed ended questions in an effort to yield quantitative data, as Roessner (2000, p126) states, quantitative data is *"extremely valuable for many analytical purposes such as making comparisons and describing trends".* This was key as the researchers focus was upon how the users of commercial buildings perceive the Health and Safety files, and how their opinions directly compare to those of Principal contractors and CDM co-ordinators,

The questionnaire therefore formatted to contain multiple choice questions and likert scales. According to Wilson and Mclean (1994, p29) *"The likert scale is a form of ranking scale where a series of statements are provided indicating attitude towards a chosen topic. The respondents are invited to indicate their strength of agreement or disagreement with each statement"*

Moser and Kalton (1971, p344) identified one problem with multiple choice which was *"if a question is asked on an issue which the respondent has not previously considered, he has little incentive to work out his views…for all he need do is simply choose one of the offered alternatives*". Attempts to remedy this course of action were taken with the addition of an 'other' box, allowing participants to express additional opinions.

The likert scales ranged from 'strongly disagree' to 'strongly agree', and even though Wilson and Mclean (1994, p30) stated *"some research may be best undertaken without a neutral*

point" in an effort to *"force respondents…on one side or the other of the fence"* (Moser and Kalton 1971, p341), a 'neutral' category was included, attempting to increase the validly of the results, as forced opinions could go either side of the scale, and not necessarily reflect the participants true views.

INTERVIEWS

Semi-structured interviews were chosen allowing the participant's freedom to answer as much or as little as they saw fit, but allowed the researcher to keep the aim of the interview focused in an attempt to ascertain as much clarity and further information as possible, and were conducted once the analysis of the questionnaire data had occurred, as highlighted points of interest were discussed in detail.

OBSERVATIONS

An observation is where *"the researcher is…immersed in the day-to-day activities of the people being studied"* (University of Toronto 2005), and was conducted within a commercial building, allowing maximum contact with participants and leading to gains in qualitative data in regards to users' knowledge of Health and Safety files.

LITERATURE REVIEW

The CDM Regulations (2007) state that the Health and Safety files should contain *"information relating to the project which is likely to be needed during any subsequent construction work to ensure the health and safety of any person"* (Regulation 2002)(e)).

This is in an attempt to reduce the number of accidents and fatalities in the construction industry, as Egan (1998, p25) reports *"the health and safety record of construction is second worst of any industry".*

THE HISTORY OF FATALITIES IN CONSTRUCTION

It is clear that fatalities in construction are not modern phenomena. Callaghan (2007, p7) reported, *"the number of fatal and non-fatal accidents in factories…and construction was over 300,000 in 1970…"* These figures can be described as accurate as they are very similar to figures ascertained from the Robens report published in 1972 (Wedderburn, 1986, p62), this in turn led to the introduction of the Health and Safety at Work Act (1974).

THE HEALTH AND SAFETY AT WORK ACT 1974 (HASAWA)

Described as *"the primary piece of legislation covering occupational health and safety in the United Kingdom"* (HSE 2008), any breach of the CDM Regulations (2007) is punishable under the HASAWA because *"The 1974 Act takes the form of an enabling statute..."* (Howells and Barrett, 1982, p7). This enabling statue sets a framework for all future regulations made under its authority to further enforce the health and safety of individuals in the workplace.

CURRENT FATALITIES IN CONSTRUCTION

According to the HSE *"In Great Britain in 2000, the same proportion of people had been injured at work since the early 1990's"* (HSE 2008) Figure 1.0 shows that has statement is not 100% accurate, as the rate of workers receiving injuries has fallen, although still remains alarmingly high.

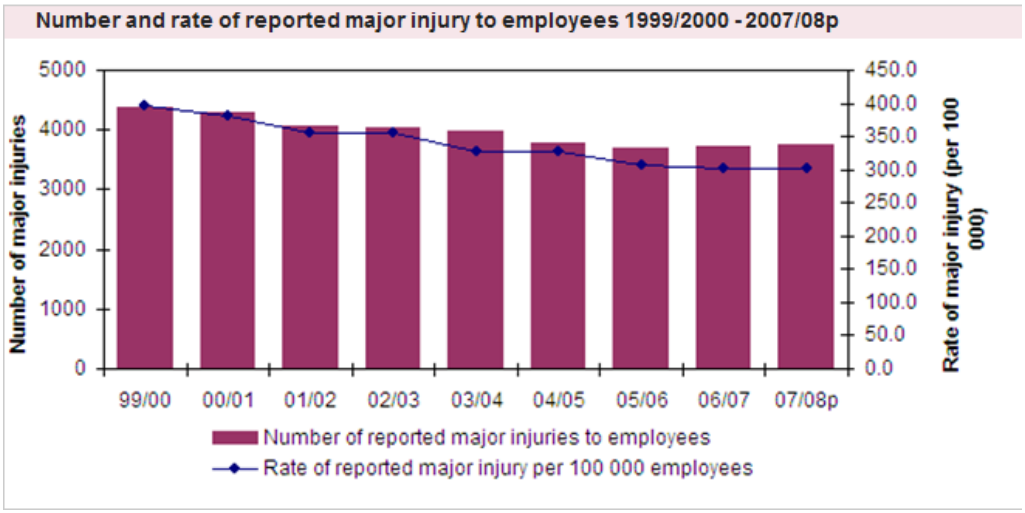

Figure 1.0 Reported major injuries (HSE 2008)

The CDM Regulations 1994 and their requirement of Health and Safety files were implemented in an attempt to tackle this issue.

THE CDM REGULATIONS (1994)

The CDM Regulations (1994) first introduced the requirement of a Health and Safety file in commercial buildings. Regulation 14(d) states that a file should contain *"...information relating to the project which it is reasonably foreseeable will be necessary to ensure the health and safety of any person at work who is carrying out or will carry out construction work..." (*CDM 1994)

THE HEALTH AND SAFETY FILE

In regard to the Health and Safety file, the 1994 Regulations were unclear *"in respect of their requirements on those who had duties under them"* (Harris, 2005, p13). They created the role of 'planning supervisor', but only stated that he should 'ensure' the files were prepared, the Regulations didn't specify whose responsibility it was to prepare the files.

THE CDM REGULATIONS (2007)

The need for the CDM Regulations (1994) to be replaced was due to slow reaction from the construction industry, and the view amongst organisations that the 1994 Regulations were largely bureaucratic. Griffiths (2007, p6) confirmed this by stating *"it is probably true to say that to say that initial CDM responses were wide of their intended mark..."*

In response to this industry feedback, the main aims of the CDM Regulations (2007) were to *make it easier for those involved in construction projects to comply with their health and*

safety duties" (www.cdm-regulations-uk.co.uk) and to *"discourage unnecessary bureaucracy"* (CDM, 2007, ACOP) An ACOP is an Approved Code of Practice which was published alongside the CDM Regulations 2007 in an attempt to advise how best to comply with the Regulations.

THE HEALTH AND SAFETY FILE

A major difference in the way the revised Regulations dealt with the Health and Safety file is the additional description given; *"a record containing information relating to the project which is likely to be needed during any subsequent construction work to ensure the health and safety of any person"* (Regulation 20(2)(e)). This additional definition gave further clarity as to what the Health and Safety file is, clarity that could not be gained from literature sources prior to 2007.

The 2007 ACOP also now states *"the file should contain"* (ACOP, 2007, p61) rather than the previous definition of *"the file provides…"* the response to this greater definition from within the construction industry can be ascertained from Joyce (2007, p181) who states *"…files created under the Regulations are records which are defined in more detail."*

THE ROLE OF THE CDM CO-ORDINATOR

As Griffiths (2007, p94) *states "The name Planning Supervisor has never sat well within the industry",* and as a result of the CDM Regulations (2007) the role of was withdrawn and replaced with the CDM Co-ordinator.

The introduction of a CDM Co-ordinator role clarified the responsibilities of those involved with the creation of the Health and Safety files. As Baker (2007, p108) stated *"There was much debate under the old CDM Regulations as to who should produce the file".* The revised Regulations clearly explain the responsibility to create and manage the file now lies with the CDM Co-ordinator. *"The CDM co-ordinator shall-prepare, where none exists, and otherwise review and update a record (the health and safety file) containing information relating to the project…"* (Regulation 20(2)(e).

THE RESPONSIBILITIES OF THE CLIENT

According to Joyston-Bechal and Grice (2004, p32) *"The CDM Regulations are revolutionary…in that they impose some responsibility in respect of safety…on the person contracting the work – the 'client'"*

While the requirements of the client in relation to the file have not changed since the CDM Regulations (1994) the client's responsibilities *"…have been strengthened"* (www.cdm-regulations-uk.co.uk). This can be seen in the CDM ACOP (2007, p61) that states *"clients…must supply the information necessary for compiling or updating the file"*

However the client still has no requirement to educate the tenants of any property in regard to the health and safety file. Even though the client is legally obliged to store the file for the

lifetime of the building (Regulation 17(3)), the tenant has no *"statutory right to require possession of the health and safety file"* (Joyce, 1995, p57)

THE RIGHTS OF THE END USER

The CDM 2007 ACOP states that the Health and Safety file *"should contain the information needed to allow future construction work, including cleaning, maintenance, alterations, refurbishments…to be carried out safely"* In order for this to happen the end user would need to have the Health and Safety file available so that it can be consulted when tackling any of the tasks outlined.

The CDM Regulations (2007) themselves offer no further guidance as to the role of the end user in regard to the Health and Safety file. The CDM ACOP (2007, p63) only states *"it may be better for the client to keep the file, but tell leaseholders that it is available"* However, as Joyce (2007, p185) comments *"there is no indication as to the time frame within which the client should produce the information"*

Therefore the end user has no legal obligation to own a copy of the file, nor be informed of the existence of one. However Joyce (1995, p57) does say *"in any event a prudent purchaser should seek possession of the health and safety file".* This may not prove so straightforward in practice, if tenants are unaware of the Health and Safety file.

THE PRINCIPAL CONTRACTORS OBLIGATIONS

Perry (2007, p163) states *"in many cases it can be extremely practical to have the principal contractor compile a draft Health and Safety file for the project as they see most of the information at first hand…"* This would make the files easier to complete as it's the principal contractor who deals with every individual involved in the construction process.

However, legally the principal contractor is under no obligation to assemble the Health and Safety file, although the contractors role is still an important one in the file's creation as the CDM Regulations (2007) state that the principal contractor shall *"…identify to each contractor the information relating to the contractor's activity which is likely to be required by the CDM co-ordinator for inclusion in the health and safety file…and ensure that such information is promptly provided to the CDM co-ordinator"* (Regulation 22 (1)(j))

ANALYSIS

COMMERCIAL BUILDING USERS

The results showed that even though the legal responsibility of the client is only to ensure the file is *"…kept available for inspection…"* (Regulation 17(3)(a)) and not to inform the end user of its existence, in all commercial building units surveyed 100% of the commercial building managers were aware of the Health and Safety file.

However 95% of employees surveyed were unaware of any Health and Safety file, a point that was reinforced through the observed case study. This lack of knowledge shows the purpose of the file, *"…to allow future construction work, including cleaning, maintenance, alterations, refurbishments…to be carried out safely"* (ACOP, p61, 2007), is not being met in commercial buildings. As 15% of employees surveyed would use equipment for the first time without instructions, and a further 36% would operate equipment when they had received only verbal instructions.

In addition it was discovered a total of 60% of employees had gained their knowledge of workplace equipment from verbal instructions, and had never seen an instruction manual of any sort. Out of the employees who had heard of the Health and Safety file, 34% believed their knowledge of workplace equipment to be detailed, compared with only 25% of those who had not heard of the file.

CDM CO-ORDINATORS

The triangulation of results gained indicate that the CDM co-ordinators are all aware of the correct purpose of the Health and Safety files, and are all aware of their legal obligations in relation to the files under the CDM Regulations (2007).

90% of the CDM co-ordinators surveyed believed the Health and Safety file to be either slightly important or very important to a project, and 75% believed their knowledge to be either good or very good of the file's requirements. This is confirmed by the mean effectiveness of 3.5 out of 5 given to the files by end users.

The questionnaire's completed by the CDM co-ordinators show that 50% of those surveyed believed the clients to fulfil this requirement 'always' and 40% believed they fulfilled it 'sometimes'. The interview conducted with a CDM co-ordinator also confirms this point as when asked if the clients fulfil this duty the reply was 'yes'. The triangulation of sources therefore confirms that currently, clients are fulfilling this part of their duties in relation to the Health and Safety file.

PRINCIPAL CONTARCTORS QUANTITY SURVEYORS

The results showed that nearly 12% of Principal contractor Quantity Surveyors surveyed are not aware of the correct purpose of the Health and Safety file. In addition 76.5% of those Quantity Surveyors were also unclear as to their legal obligations under CDM 2007. As the Quantity Surveyors believed they were required to give the CDM co-ordinator a completed Health & Safety file, whereas it is only stated that they *"…must supply the information necessary for compiling or updating the file*" (CDM ACOP, 2007, p61) This incorrect belief of legal obligations was confirmed in the interview held with a Quantity Surveyor.

The Quantity Surveyors surveyed also gave a mean score of 3.21 out of a 5, when asked how effective they believed the files were for end users, showing that overall, they believed the files to be quite effective. However with a standard deviation of 1.26, we can see that the opinions of the Surveyors varied significantly.

CLIENTS

The data collected also shows that clients are fulfilling their legal duty outlined by Regulation 17(4) *"it shall be sufficient compliance…by a client who disposes of his entire interest in the structure if he delivers the health and safety file to the person who acquires his interest and ensures he is aware of the nature and purpose of the file"* (CDM 2007) As 38.5% of end users surveyed said they had received a Health ad Safety file from the previous owner of the building, compared with only 19.3% of end users who said they hadn't. This shows that a large proportion of clients are definitely complying with the CDM Regulations (2007), although a few clients are still not.

DISCUSSION

The aims of the research were to 'review the current legislation, practice, and methods surrounding the Health and Safety file' and 'determine the adequacy of current standards of Health and Safety files in terms of end user application'.

As we can see from the literature review, the progression of health and safety in the construction industry led to the CDM Regulations (1994) that first created the need for a Health and Safety file to be prepared in respect of commercial buildings. Regulation 14(d) stated that a Health and Safety file should contain *"information included with the design…" and "any other information relating to the project which it is reasonably foreseeable will be necessary to ensure the health and safety of any person at work who is carrying out or will carry out construction work…"*

However as reported by Harris (2005, p13) the Regulations were unclear *"in respect of their requirements on those who had duties under them"*. The implementation of the CDM Regulations 2007 led to the revised legal obligations in relation to the Health and Safety files. The definition of the Health and Safety file was improved to include the previously mentioned definition and the additional definition of *"a record containing information relating to the project which is likely to be needed during any subsequent construction work to ensure the health and safety of any person"* (Regulation 20(2)(e))

These revised legal obligations are what are enforced today, and the knowledge of which, was ascertained from both CDM co-ordinators and principal contractors Quantity Surveyors.

CDM CO-ORDINATORS

The results showed that the CDM co-ordinators understood their role fully in regards to the file, and fulfilled their duties satisfactorily when judged on end user satisfaction of the files., and as 100% of the Quantity Surveyors surveyed had heard of a Health and Safety file, it can be concluded that currently CDM co-ordinators are doing their required roles correctly.

The interview conducted with a CDM co-ordinator also confirms this point as when asked if the clients fulfil this duty the reply was yes. The triangulation of sources therefore confirms

that currently, clients are fulfilling this part of their duties in relation to the Health and Safety file.

QUANTITY SURVEYORS

However, 12% of Quantity Surveyors were unaware of the correct purpose of the Health and Safety files, and 76.5% of those surveyed were unclear of their duties under the CDM Regulations (2007), showing that either the Regulations do not specify what is required of each party in enough detail, or principal contractors have not been quick enough to train their staff in relation to the revised Regulations.

CLIENTS

The data collected also shows that clients are fulfilling their legal duty outlined by Regulation 17(4) *"it shall be sufficient compliance…by a client who disposes of his entire interest in the structure if he delivers the health and safety file to the person who acquires his interest and ensures he is aware of the nature and purpose of the file"* (www.cdm-regulations-uk.co.uk/#link1), as 38.5% of end users surveyed said they had received a Health ad Safety file from the previous owner of the building, compared with only 19.3% of end users who said they hadn't. This shows that a large proportion of clients are definitely complying with the CDM Regulations (2007, although a few clients are still not.

The CDM Regulations 2007 do not impose an obligation upon the client to inform users of commercial buildings about the existence of the Health and Safety file. The client therefore has no requirement to educate the tenants of any property in regard to the file, or of its existence and appropriate benefits. However, as 100% of the commercial store managers surveyed knew about the health and safety file, it can be ascertained that clients do inform the building users in respect of the Health and Safety file.

The questionnaire's completed by the CDM co-ordinators show that 50% of those surveyed believed the clients to fulfil there requirements 'always' and 40% believed they fulfilled it 'sometimes'. Therefore clients are currently fulfilling their legal obligations under CDM Regulations (2007), and going further then required by informing end users and building occupiers.

THE PRINCIPAL CONTRACTOR

According to the CDM Regulations (2007) the principal contractor is required to *"…identify to each contractor the information relating to the contractor's activity which is likely to be required by the CDM co-ordinator for inclusion in the health and safety file…and ensure that such information is promptly provided to the CDM co-ordinator"* (Regulation 22 (1)(j))

Therefore the minimum limit of a principal contractors compliance with the CDM Regulations will be reached if they inform each sub-contractor what they need to do in relation to the file. The data analysis showed that Quantity Surveyors believed the Regulations explained their obligations quite effectively. However 76.5% of the surveyed

Quantity Surveyors believed their obligations under the Regulations was to 'provide the CDM co-ordinator with a completed Health and Safety file'.

The QS's surveyed believe they have a good knowledge of their requirements in relation to the file, although they are actually doing more work on the compilation of the file then is legally required. This is confirmed by the interview conducted with a QS as he states that he has a good knowledge of what the Regulations require, and that he compiles a complete file to give to the CDM co-ordinator.

CONCLUSION

In conclusion, the legal obligations under the CDM Regulations (2007) are currently being met by both CDM co-ordinators and Principal contractor Quantity Surveyors, although a high percentage of QS'S are still unclear as to what is legally required of them, they are currently doing more work then necessary to fulfil their obligations.

The quality of the files is rated as highly effective by all parties involved, however CDM co-ordinators do believe them to be of a higher standard than that rated by end users.

The research also highlighted the fact that even thought the CDM Regulations (2007) are an improvement on previous legislation, the Regulations do not place a legal requirement on the client to deliver the Health and Safety file to the end users of the building. This is an important area as without knowledge of the file, end users of commercial buildings cannot safely perform maintenance, cleaning and refurbishment work, which is the primary purpose of the Health and Safety file.

Although the end users surveyed had had a Health and Safety file handed to them from either the previous tenant or the building owner, in all cases the management of the building had been informed of the files existence, but a large majority had not passed this knowledge on to the building's supervisors and employees.

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AN INVESTIGATION INTO THE NON-UNIFORM DECAY OF HARDWICK STONE

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Hardwick stone as used on the vernacular Hardwick Estate buildings decays in a non-uniform way. Typically stones at Hardwick decay cavernously leaving the mortar matrix behind. Levels of decay can vary dramatically from stone to stone with one stone showing advanced decay whilst adjoining stones are relatively intact. Ten sample buildings giving a total of 1587m² of elevations and with a good geographical spread across the estate were surveyed. Ratings were assigned according to condition. It was shown with 95% confidence that the weathering on the western elevations is significantly worse than that seen on the eastern elevations of the sample buildings. Northern elevations had high levels of stonework in good condition, while western elevations had the lowest. The prevailing wind direction on the Estate is west to north-west. The difference in levels of decay below 1 metre and above 1 metre has been shown to be significant at the 95% confidence level with a slight correlation between levels of stone decay and building height (above sea level). The survey also highlighted stone decay parallel to, but offset from, the roofline where there were no overhanging gables present. In contrast, buildings constructed with protruding cills were often observed to have areas of decay underneath the cills. Stone decay often appears to be associated with the path of the chimney.

Keywords: Sandstone; Weathering; History

INTRODUCTION

The vernacular buildings on The Hardwick Hall estate have little in common with the magnificence of the Elizabethan Hall except that most of them, and the Hall, are constructed from the same material: Hardwick Stone, originally obtained from the now disused quarry on the estate. The new quarry at Hardwick is still in operation and stone from this is used for repairs. According to the BGS data both quarries sit in an area of sandstone from the Pennine Middle Coal Measures Formation.

This stone displays remarkable decay characteristics. Some stones decay cavernously leaving the mortar matrix behind and in extreme cases an aperture to the rubble core. Parts of other stones show advanced decay whilst other parts are relatively intact and other stones show little sign of decay. These features can be seen occurring in buildings across the estate on all elevations. It was the purpose of this research to investigate the non-uniform decay of this stone, to discover whether any trends or patterns in its decay could be established and to suggest reasons for this decay. The results of this research may help with the financial and logistical planning of future estate repairs.

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RATIONALE

The mapping of stone weathering was undertaken using the classifications of weathering forms and intensities.

Consideration was given to several systems of assessing stone condition used in literature sources. "The mapping method represents a non-destructive, well established procedure, which allows the quantitative evaluation of complete stone surfaces according to type, intensity and distribution of weathering forms. It makes an important contribution to rating of weathering damage, weathering prognosis, information on causes and processes of stone weathering and to sustainable monument preservation" (Fitzner, Heinrichs and La Bouchardiere 2002, p. 224 cited Fitzner *et al* 1995). Detailed schemes such as those proposed by Fitzner *et al* (2002) in mapping of the ancient structures in Cairo allowed "detailed registration of weathering forms" and was used as a "basis for the quantitative rating of stone damage by means of damage categories and damage indices." (2002, p. 217), however these were deemed too detailed to acquire a statistically viable sample derived from the Hardwick estate buildings. Systems of condition survey detailed by Warke *et al* (2003) were also considered.

It was decided to use a system complimenting The National Trust's quinquennial structural and condition survey system, as the Trust is the body who maintains the buildings. As part of the quinquennial survey the external walls would be examined. In undertaking this research every elevation was split into a grid of 1m² areas each of which had a condition value assigned to it. Masonry in good condition that is functioning as designed was rated as 'good – requires no attention' while masonry that is showing signs of decay to an extent that it may need replacing or at least flagging up for special attention at the next quinquennial was rated as 'some decay – requires monitoring'. Masonry that had decayed to such an extent that it required replacement before the next quinquennial was rated as 'severe decay – requires replacement'. Stone already replaced due to failure was also noted. Richard Lambert, National Trust Building Surveyor, states that stone becomes critical in terms of its structural role when the decay is approaching 50% of its depth (pers. comm. November 2007).

Literature highlighted a number of areas which would require investigation. Robinson and Williams (1996, p. 137) believe that one of the most important factors affecting the degree of weathering is height: "The most weathered blocks tend to be found towards the base of walls, within the capillary fringe … Window surrounds also appear to be particularly susceptible to weathering." Figure 1 illustrates the moisture regime on a typical historical façade, after Duffy and O'Brien (1996, p. 257). They also state that the upper 25% of the façade receives 60% of the driving rain. Duffy and O'Brien. Their diagram shows that projecting cills protect the elevation below keeping them drier as a cill is designed to throw water away from the elevation. The distribution of badly decayed stone directly with relation to the cills was also investigated at Hardwick.

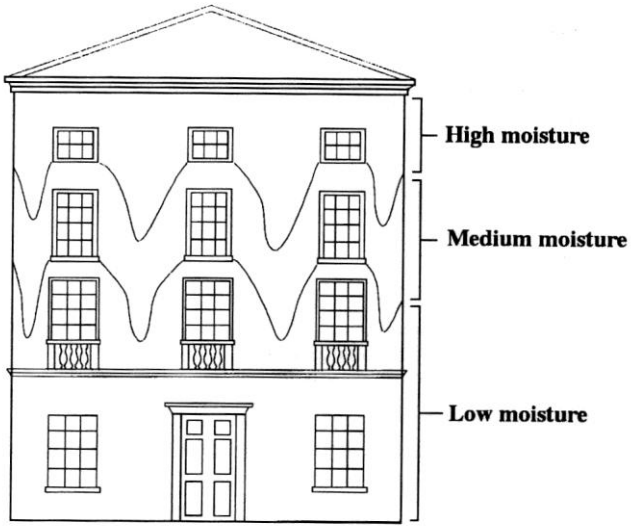

Figure 1: Inferred moisture regime on a typical historic façade Duffy and O'Brien (1996, p. 257)

All elevations were mapped in terms of the 4 categories of the quinquennial survey noted above and statistical analysis carried out on the data to discover whether perceived differences in results were significant or not. In addition to the field work, extensive laboratory work was undertaken, but is not presented in this paper.

Details of selected surveyed buildings

Norwood Piggeries

This building was built as a pigsty to house animals belonging to the occupants of Norwood Cottages. Like the cottages, it was built in 1874 (National Trust Vernacular Building Survey – 2 Norwood Cottages, 1997, p.1). The building although built as an animal shelter is now used as a garden shed. There has been no replacement of stonework to date and some of the existing stone is badly decayed, and is particularly severe and widespread on the southern elevation, Figure 2, although there is some decay evident on the other elevations. The building's roof has significant overhangs, which may have affected the manifestation of decay levels on the southern and northern elevations.

The southern elevation has the lowest proportion of stone in good condition (36%). The eastern elevation has the highest proportion of stone in good condition (69%). The average for all elevations is 55%. The northern elevation has the highest proportion of stone showing signs of decay (42%). The eastern elevation has the lowest proportion of stone in this category (24%).

Figure 2: View of southern elevation Norwood Piggeries

Figure 3: Example of cavernous weathering, southern elevation Norwood Piggeries

Figure 33 is a detailed photograph of one of the stones exhibiting cavernous decay in the southern elevation of Norwood Piggeries. In this photograph it is possible to see that the cavern passes right through the stone and it is possible to see mortar and the rubble core behind.

Rowthorne Lodge

The National Trust vernacular building survey for Rowthorne Lodge states that it was constructed in approximately 1827 (National Trust Vernacular Building Survey - Rowthorne Lodge, 1997, p.1). The central protruding section of north elevation has been extended at ground floor level at some point and is not built with Hardwick Stone. This building, although small, was finished to quite a high standard. It is generally in good condition, and there is no stonework in the worst two categories i.e. needs replacing or has been replaced. The stone showing some signs of decay on upper levels follows the path of the flues due to combustion by-products. The roofs have a slight overhang, this is more pronounced on the roof over the central two-storey section. Figure 54&5 show how the exterior stone decay appears to follow the path of the flue.

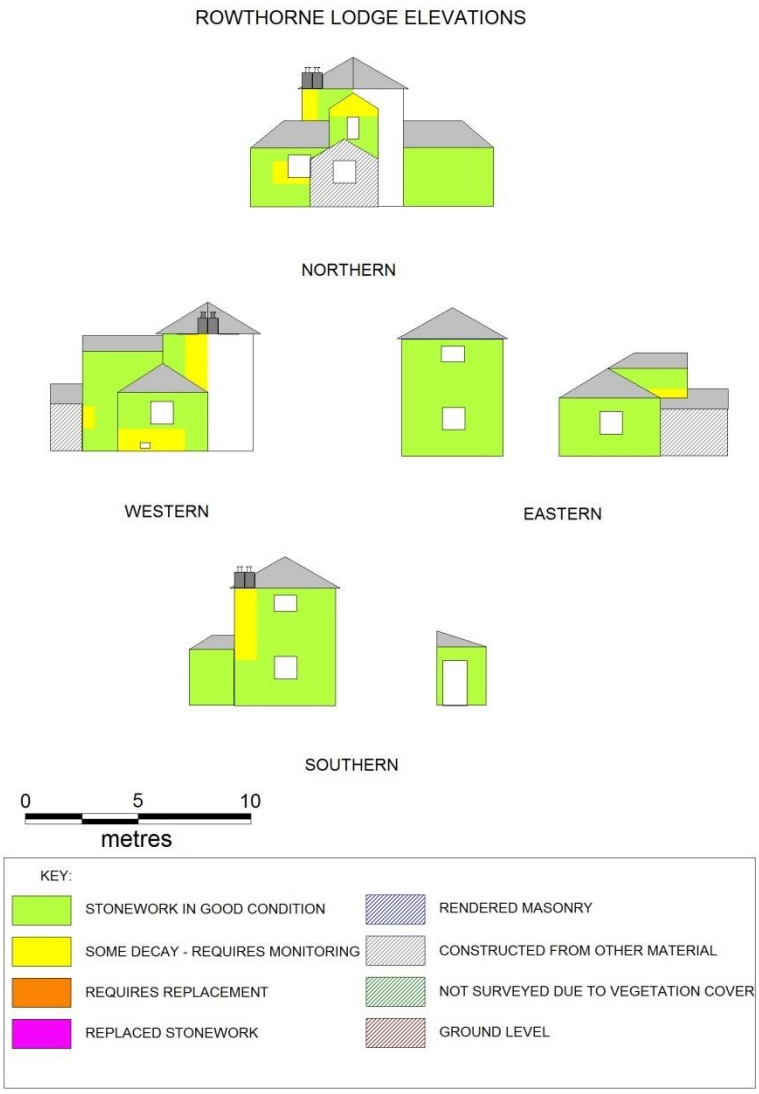

Figure 4: Elevations of Rowthorne Lodge

Figure 5: Stone decay along route of flue

The western elevation has the lowest proportion of stone in good condition (74.5%). The eastern elevation has the highest proportion of stone in good condition (98%). The average

proportion of stone in good condition for all elevations is 88%. Apart from the flues the other locations where there is stonework showing signs of decay are on the northern gable, around the cill on the northern elevation and mainly at low level on the western elevation.

The Grange

This building has a date stone of 1724, although the rendered section is believed to have been constructed in the nineteenth century. There is a fair proportion of stone replacement in evidence. The roof does not overhang any of the elevations. There are a mixture of window designs, some with projecting stone cills and others that are flush. It is noticeable that the decayed stonework occurs at low level on this building and also on the central and upper sections of two of the gable ends. Interestingly the third un-rendered gable end does not show this decay pattern. Figure 66 illustrates the extent and severity of stone decay on this building.

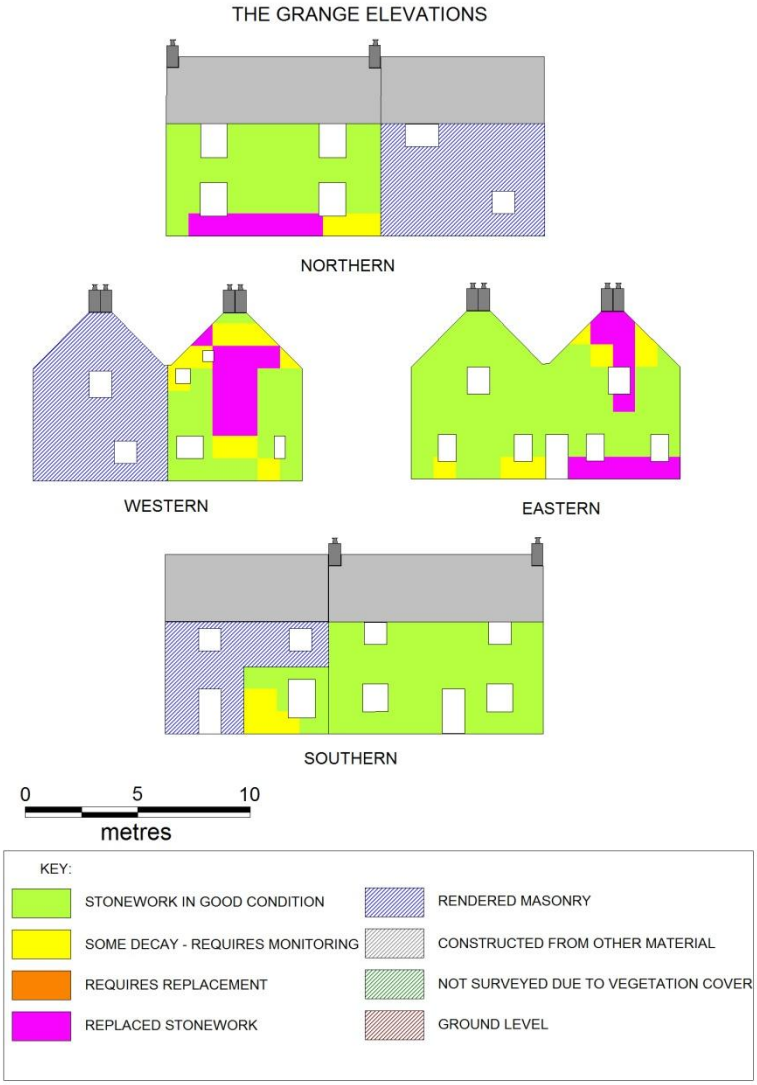

Figure 6: Elevations of The Grange

The elevation with the highest proportion of stone in good condition is the southern elevation (92%), the western elevation has the lowest proportion of stone in good condition at 52%, with an average over all the elevations of 77%. The western elevation has the highest proportion of stone that is showing signs of decay (22%) and also the highest proportion of stone that has been replaced (26%).

The Croft

This building is built around 3 sides of a courtyard, with the southern side open. It therefore forms an 'n' shape. Due to this shape the external elevations were surveyed as 'The Croft.' The southern elevation of the building facing into the courtyard was included in this survey as the southern end of The Croft is the open end. The other 2 elevations that face into the courtyard were surveyed as 'The Croft Courtyard.' Figure 7 shows the extent and severity of stone decay to The Croft, Figure 8, **Error! Reference source not found.**shows the extent and severity of stone decay on The Croft Courtyard elevations. Due to the size of this building the elevations are shown at a slightly smaller scale than others illustrated in this paper.

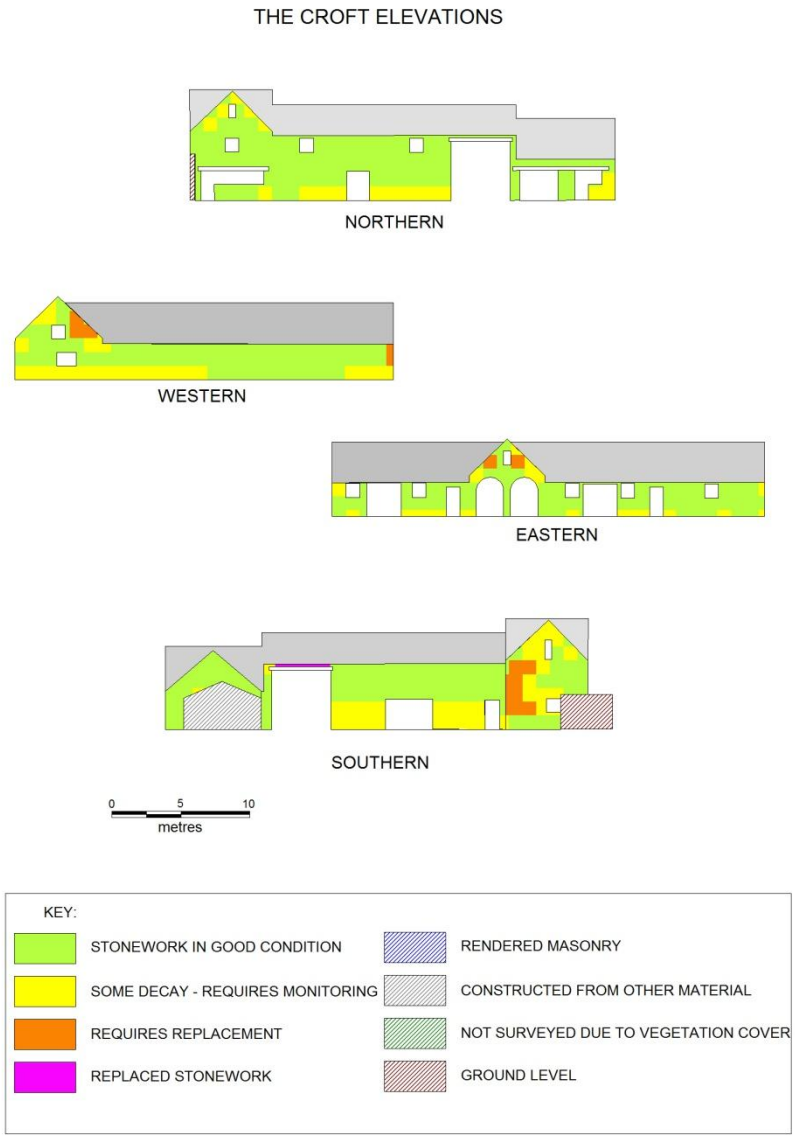

Figure 7: Elevations of The Croft

Figure 8: Elevations of The Croft Courtyard

The roofs of the Croft building are dual pitch covered with stone slates. They do not overhang any of the elevations to any significant degree. There are multiple openings to the elevations performing a variety of functions. The condition of the stonework in the elevations varies. The elevation in worst condition is the western elevation of The Croft Courtyard.
The elevation with the lowest proportion of stone in good condition is the southern elevation (64%), whereas the highest proportion of stone in good condition was observed on the northern elevation (83%) with an overall average for all elevations of 73%. The southern and western elevations have higher than average figure for stone showing some signs of decay, 28% and 27% respectively. The southern, eastern and western elevations all have some stone requiring replacement, whereas the northern elevation does not. In the case of The Croft Courtyard, both elevations have a low proportion of stone in good condition. The eastern elevation has 44% in good condition, the western elevation fairs slightly better at 52%. The average for these two elevations is 51%. The eastern elevation has a high proportion of stone that is showing some decay (56%), whereas the western elevation has 39% in the same category. The western elevation also has 9% of its stone requiring replacement.

One of the most striking features of this elevation mapping is how the spread of stone showing signs of decay appears to occur high up in the building, towards the southern end of the western elevation which may be attributable to the fact that the southern end is the open end of the courtyard and therefore this part of the building is least protected. Decay at high levels in the elevations can also be seen on the eastern gable of the southern elevation in Figure 7. Another feature of the pattern of stone decay on The Croft is that decay appears to occur on the gables of the buildings parallel to, but offset from, the roof line. This is not shown perfectly by the elevation mapping because the elevations have been split into 1m grids.

This pattern of offsetting of the areas of higher levels of decay when gables are present can be seen on other, similar, elevations on other estate buildings; notably Yew Tree Farm, The Grange and The Grange Outbuildings 1 & 2 for example. It does not occur on buildings with overhanging roofs however, Norwood Cottages and Stainsby School being good examples.

Stainsby School

This building was constructed in 1895 (datestone) as a boys school for the village of Stainsby. The extent and severity of the stone decay on this building is illustrated in Figure 9.

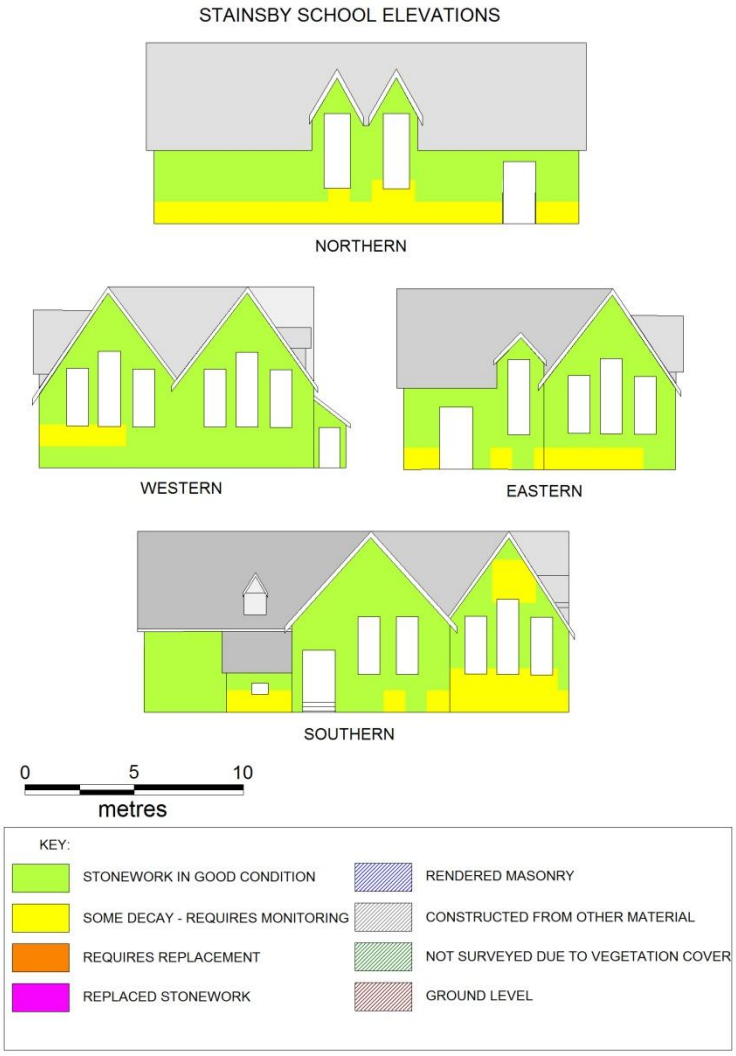

Figure 9: Elevations of Stainsby School

The building is of single storey construction with an overhanging clay tile roof. There are large windows to all elevations with projecting stone cills. Overall the stonework is in good condition. There is no stone in the worst two decay categories and much of the stone is in good condition. Where there are signs of some decay this tends to occur at low level except for some to a gable on the southern elevation and some under a cill on the western elevation. All elevations have high proportions of stone in good condition. The highest proportion occurs on the western elevation (93%), the lowest on the northern elevation (69%). The average for all elevations is 80%. The northern elevation has the highest proportion of stone that is showing signs of decay (31%). The western elevation has the lowest (7.5%)

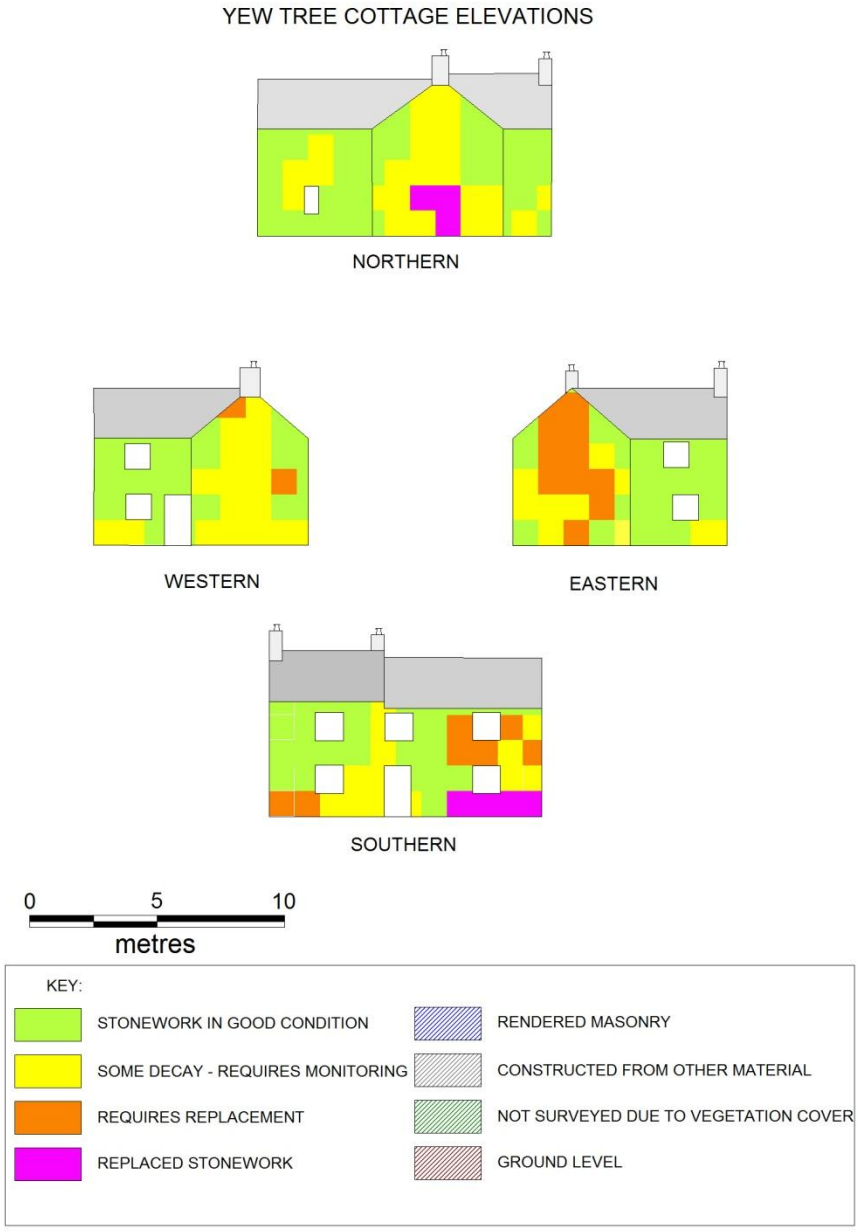

Figure 10: Elevations of Yew Tree Cottage

Yew Tree Cottage

Yew Tree Cottage is one of the older buildings that make up the sample in this survey. The National Trust Vernacular Building Survey dates it as late eighteenth century with nineteenth

century alterations/extensions (The National Trust Vernacular Building Survey – Yew Tree Cottage, 1997, p.1). The roof does not have any significant overhang to any elevation. The building forms a 'T' shape and has three gable ends. There are chimneys to two of these gables and the third (eastern) appears to have had its stack removed at some point. There are windows of differing styles in this building, some have protruding cills and some are flush. This building has a lower proportion of stone in good condition compared to many of the other buildings in this survey. There is a suggestion in the Vernacular Building Survey for this property that the stone for this building came from a small quarry in the Hamlet of Astwith local to the building (The National Trust Vernacular Building Survey – Yew Tree Cottage, 1997, p.1).
This may mean that the stone in this building is slightly different to the stone used in other buildings in the sample. It does display the same weathering characteristics however. Figure 10 illustrates the severity and spread of stone decay at Yew Tree Cottage.
The proportions of stone in good condition is low for all elevations, the worst elevation being the southern elevation (48%) and the best being the northern elevation (55%). The western elevation has 50% of stone in good condition and a further 45% showing signs of decay. This leaves 5% requiring replacement. The eastern elevation has the lowest proportion of stone showing signs of decay (23%), but has the highest proportion of stone requiring replacement (27%). The southern elevation has the highest proportion of stone that has been replaced (9%).

Combined results for all buildings surveyed.
The data gathered from the buildings surveyed has been aggregated and plotted as a graph. This groups elevations of the same direction together. This data is shown graphically in Figure 11:

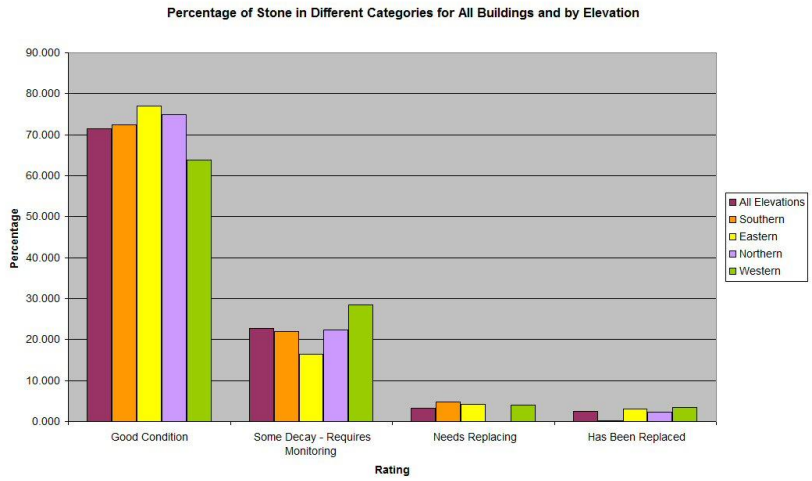

Figure 3: Graph of stone condition for all buildings

As can be seen from above the eastern elevations of the buildings surveyed have the highest proportion of stone in good condition (77%). The western elevations have the lowest proportion of stone in good condition (64%). The average for all elevations is 71%. The western elevations also have the highest proportion of stone that is showing some signs of decay (28%), the eastern elevations have the lowest (17%). The southern and northern elevations are close to the average figure for all elevations in this category both at 22%. The average is 23%. The northern elevations have no stone that requires replacement although 2% of northern elevations have already had stone replacement. The average for all elevations in

this category is 3%. The southern elevations have the highest figure at 5% followed by the eastern and western elevations at 4%.
Across all elevations the average proportion of stone that has been replaced is 2.5%. The southern elevations have only had 0.3% replaced, the eastern elevations have had 3%, the northern 2.3% and the western have the highest proportions of stone replacement at 3.5%.
Given the difference between the proportion of western elevations that have stone in good condition and the proportion of eastern elevations that have stone in good condition the Chi-square test has been applied to the data to assess whether this apparent difference is statistically significant or not. The Chi-square test was used and it can be said with 95% confidence that the two sets of results are significantly different between the amount of weathering occurring on the western elevations of the sample buildings and the amount of weathering occurring on the eastern elevations. Ted Edwards, Head Warden Hardwick Hall Estate, (pers. comm. March 2008) states that the prevailing wind direction at Hardwick is west to north-west. This could help to explain the difference in weathering observed between the western and eastern elevations, however it would not necessarily explain the lower weathering seen on the northern elevations, as Figure 11 shows, the northern elevation has the second highest proportion of stone in good condition at 75%. This is an interesting finding as it may be expected that the northern elevation would receive high levels of wind and rain and low levels of insolation. Robinson and Williams (1999, p.11) investigating the weathering of Hastings Beds sandstone gravestones suggested that the more severe weathering of gravestones on their western sides could be attributed to their facing the prevailing wind, and thus being more frequently rain-soaked as well as them being sun-lit in the later parts of the day when air temperatures are highest, which may cause them to become drier than the eastern sides. This might indicate that decay is by cyclic wetting and drying rather than frost or chemical degradation.

Building's use

Part of the hypothesis for this project stated that the level of decay would be dependent on the building's use. As buildings can have many uses the buildings have been categorised into 1 of 2 classes: designed for human occupation and not designed for human occupation. The graph below shows the proportions of stonework in each category by building's use.

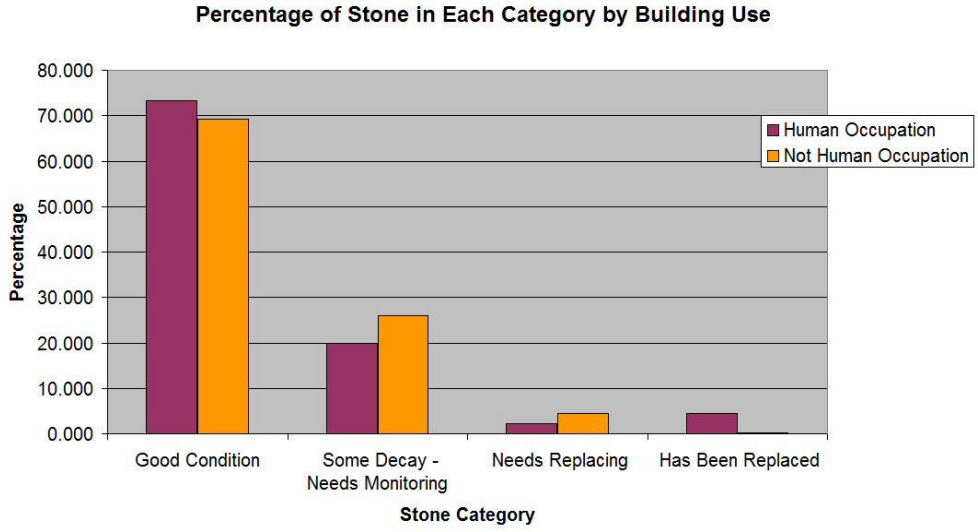

Figure 124: Graph of stone condition by building use

As can be seen from Figure 12412 those buildings designed for human occupation have a slightly higher proportion of stone in good condition than those designed for other uses 73%

and 69% respectively. Buildings not designed for human occupation have higher proportions of stone that is showing signs of decay or needs replacing. Stone replacement has been almost totally restricted to buildings designed for human occupation 4.5% compared to 0.11% for buildings not designed for human occupation.

There are various reasons as to why stone might fare better on buildings designed for human occupation. They are generally built using better materials, techniques, designs and craftsmanship in the first place. For example a number of buildings designed for human occupation have overhanging roofs which provide protection to the walls. They have more efficient mechanisms for carrying rainwater off the roof and away from the building i.e. functioning gutters and downpipes. In addition there is more likelihood of earlier and effective care and maintenance, for example a building that is occupied by humans is less likely to be damp as the occupiers are likely to take steps to rectify any dampness and the internal space will be heated. Buildings not designed for human occupation probably suffer more abuse over their lifetimes. For example: buildings that have been used as animal shelters often have contaminated masonry due to contact with animal waste which occurs over a period of many years. Water is a major agent of decay since water can transport salts into the pore spaces of stones, either from the ground or other sources; cause decay due to the freeze-thaw process and can also cause decay due to its acidity. The text above sets out a number of reasons why buildings designed for human occupation may suffer less from water penetration and therefore from salt crystallisation, freeze-thaw and acid attack. However the Chi-square test has been carried out on the data for the relative proportions of stone in good condition for human and not-human occupation. The results of the test show there is no significant difference between the two sets of data and thus the hypothesised better quality of stone in human habitations cannot be proved by the observations made.

Stone height in the elevation and relation to damage

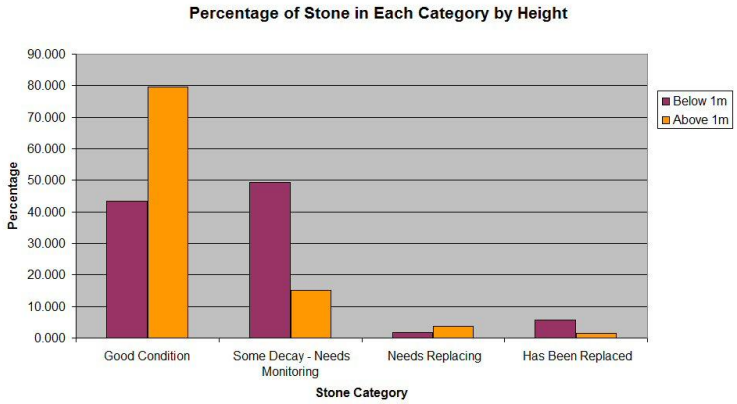

Figure 13: Graph of stone condition by height above ground level

Whilst carrying out the survey of the buildings detailed in this report it became apparent that much of the decay seemed to occur at low level; up to 1 metre in height from the ground level. The graph below illustrates the percentages of stone in the different categories for stonework below 1 metre and stonework above 1 metre in height.

Figure 1 illustrates large differences in the condition of the two sets of stone in the first two categories. Only 43% of stone below 1 metre in height is in good condition, whereas 79% of stone above 1 metre in height is in good condition. 49% of stone below 1 metre is showing signs of decay compared to only 15% of stone above 1 metre. Results for stonework that needs replacing, although low in percentage terms, are markedly different from each other.

1.6% of stone below 1 metre needs replacing compared to 3.7% of stone above 1 metre. These figures are in contrast to the results for the previous two categories. The percentage of stone that needs replacing above 1 metre is more than double that below 1 metre. This may be explained in part by the final category however. 5.7% of stone below 1 metre has been replaced compared to 1.6% of stone above 1 metre. This may be due to higher rates of decay in the low level stone. The fact that more stone at higher level requires replacement could be due to access difficulties. That is to say low level stone can be replaced by the masons without the need for scaffolding, specialist equipment etc. Therefore stone in poor condition at a higher level will probably not be replaced until there is a sufficient quantity of work required to make scaffolding and other equipment economic. The Chi-square test has been applied to the data for proportions of stone in good condition to assess whether the perceived difference in the results is statistically significant or not. The calculated value for Chi-square is 27.44. The value for Chi-square at the 95% confidence level is 3.84 Naoum (2007, p.199). Therefore it is said with 95% confidence that the two sets of results are significantly different.

With consideration of location of stone it is expected that the capillary fringe will be more at risk and that areas under the cills will be less at risk. At Hardwick it was found that weathering patterns in the capillary fringe agreed with that anticipated from the literature review, however in contradiction to accepted theory, the area directly under the cill often exhibits signs of decay.

Stone decay and height above sea level

A factor in a building's location is its height, i.e. its height above sea level. There appears to be a broad relationship of increasingly damaged stonework with elevation, but these underlying trends may be altered by the affect of local conditions, such as tree cover or local topography for example. The Grange and outbuildings are the highest buildings in the survey at 170m, however to the immediate west there is a tract of mature woodland. It could be argued that the buildings should be afforded some protection from this plantation. Stainsby School is lower at 120m but it sits on top of a small hill, surrounded on three sides by open fields and is therefore quite exposed.

Stone decay and age of building

It might be reasonable to assume that the older a building is, the worse the observed stone decay would be Scatter graphs have been produced which plot building age against percentage of stone in the worst two damage categories, as in Figure 14.

There appears to be a general correlation between building age and the percentage of stonework in the worst two damage categories, the older a building is, the higher the proportion of damaged stone, indicating that decay continues throughout the life of the building in a progressive, although not necessarily linear, manner. Factors such as the quality of the stone used, the local topography, the building's design, the maintenance regime will also affect the rate of decay.

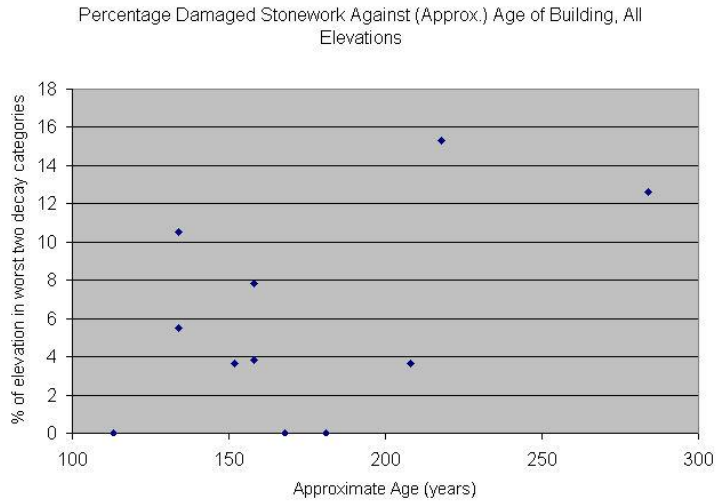

Figure 14: Graph of stonework damage against building age - all elevations

DISCUSSION

Research was proposed into the decay of Hardwick Stone due to the non-uniform nature of this decay. Secondary research has been undertaken with regard to assessing building stone condition, the causes of stonework decay and materials testing. A Selection of appropriate buildings were chosen as a sample. The elevations of these buildings were surveyed and the location and severity of stone decay on these elevations was mapped. This data has been aggregated, mapped and displayed graphically to provide a variety of statistical information.

It has been shown with 95% confidence that the weathering on the western elevations is significantly worse than that seen on the eastern elevations of the sample buildings. This may be due to the fact that western elevations are subjected to higher levels of driving rain and that the eastern elevations are more sheltered. Northern elevations had high levels of stonework in good condition. This was not necessarily expected given that the prevailing wind direction on the Estate is west to north-west. The northern elevation may experience lower levels of insolation and therefore less drying. If the northern elevations are generally damper this may mean that there is less chance of salt crystallising in stone pores. This could be an explanation for the higher levels of stone in good condition on these elevations. This could also explain why the southern elevations have the second lowest levels of stone in good condition; i.e. they have high levels of insolation and therefore experience more extreme wetting and drying cycles than other elevations.

During the survey it was noted that patterns of decay were observable across different buildings. The most noticeable of which was the concentration of decay at low level, below 1 metre in height. The difference in the amount of stone in good condition above and below 1 metre in height has been shown to be statistically significant at the 95% confidence level. Low level stone has a much lower percentage of stone in good condition (43%) than does higher level stone (79%). This is despite the fact that upper areas of elevations receive more driven rain. Water may be the cause of this low-level decay however; water running down the elevations, water splashing onto elevations from ground level and water passing up into the stonework from the ground by capillary action will affect the lower level stonework. As has been seen water is an important part of the process in the three areas of stone decay which have been tested as part of this research.

Patterns of decay on gables without overhanging roofs were also noted. This pattern is in the form of stone decay parallel to, but offset from, the roofline. This pattern was observed on a

number of buildings e.g. The Croft, Yew Tree Cottage, The Grange and The Grange Outbuildings. It was notably absent from buildings with overhanging roofs, Norwood Cottages and Stainsby School for example. The reason for this decay pattern is not clear and would require further research.

The survey recorded that buildings constructed with protruding cills often have areas of decay underneath the cills. As Duffy and O'Brien (1996, p. 257) note projecting cills generally decrease the moisture in the stonework below them. Therefore this is another area that requires further investigation. Decay under the projecting cills on buildings at Hardwick is often worse than the immediate surrounding area. This could be due to something as simple as a lack of a drip groove in the soffit of the cill or there may be more complicated processes at work.

On a number of buildings stone decay appears to be associated with the path of the chimney. This may be due to the by-products of combustion leaching through the stone and causing decay. Confirmation of this and the exact processes at work would require further investigation.

Part of the hypothesis of this research stated that levels of stone decay would be affected by the building's use. This use was categorised as either human occupation or none human occupation. Possible reasons why a building designed for human occupation may have lower levels of decay have been examined (e.g. quality of materials, quality of construction, levels of maintenance, heating, rainwater goods etc.) however, the recorded difference was not shown to be significantly different. It was noted that buildings designed for human occupation appear to have had higher levels of maintenance e.g. 4.5% stone has been replaced compared to 0.12% for buildings not designed for human occupation. It is perhaps not surprising that the buildings people live in are better maintained than those used for other purposes. It may be that in practice the quality of the materials used in the construction of these buildings did not vary between buildings designed for human occupation and those not. Quarried stone may simply be classed as good enough to use or not. Similarly the quality of the construction may not have varied significantly either as most buildings would have been built by the Estate masons.

Attempts were made to identify a correlation between height of the building above sea level and levels of decay. It appears that the amount of stone decay does increase with building height. This trend seems fairly vague but there are other factors at work which also affect the level of decay. The theory behind the height/degree of decay correlation is that the higher a building the more exposed to the elements it is. There are height differences between the buildings at Hardwick. The lowest is 120m and the highest is 170m. The amount of exposure to the elements is not solely a factor of height, however. Yew Tree Cottage and The Grange occupy high positions and yet both are sheltered to a degree by their locality. In the case of Yew Tree Cottage the shelter is provided by the land, which rises to the west. In the case of The Grange there is a tract of woodland to the west. Stainsby School whilst being low lying, sits on top of a small hill with open fields to three sides.

A scatter graph was produced to see if a correlation between building age and degree of decay could be observed. This was felt to be a reasonable assumption as decay occurs over time. However the pattern was not as well defined as might be expected. It appears that there is a trend for the decay to be worse in older buildings, but this is not always the case. Norwood Piggeries, for example, is, at 134 years old, one of the younger buildings in the sample and yet it had a figure of 10.5% of stone in the worst two decay categories. Rowthorne Lodge at 181 years old, on the other hand, had 0% of its stone in the worst two decay categories. The two oldest buildings in the sample, The Grange (284 years old) and

Yew Tree Cottage (218 years old) had the highest percentage of stone in the worst two decay categories at 12.6% and 15.3% respectively. As with the height of the building, the correlation between building age and degree of decay may not be as clear a pattern as may be expected due to the other factors at work.

CONCLUSION

The building stones at Hardwick decay by cavernous weathering but this is inconsistent even in the same course of a building such that neighbouring stones may show radically different decay levels. There appears to be a correlation between the height of a building and the levels of decay present and a correlation between the age of a building and the levels of decay present. Factors such as a buildings use has been identified as having a possible affect, but this has not been shown statistically to significantly affect levels of decay, probably due to the local proximity of the source quarries. Decay is also associated with the path a flue takes, thus by-products from chimneys have a noticeable affect on levels of decay. The direction that the elevation faces affects stone decay. It has been shown with 95% confidence that western elevations have higher levels of decay than eastern, where the prevailing wind direction on the Estate is west to north-west. Stonework below 1m in height has higher levels of decay than stonework above 1m. This has been shown to be significant at the 95% confidence level. The survey also highlighted stone decay parallel to, but offset from, the roofline where there were no overhanging gables present, and gives a strong indication that even minor protection of the stone causes a displacement of decay, rather than removing it altogether and indicates the importance of saturation and drying to the decay mechanisms operating.

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