THE PIX PROTOCOL: A RISK REDUCTION TOOL FOR CONSTRUCTION PROJECTS

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Executive summary

This paper sets out a case for the development and adoption of a PIX (Project Information eXchange) Protocol as a tool for risk management on construction projects. Risk management is becoming a much more important area to address for clients and their advisors and the PIX Protocol can be seen as a useful tool in managing significant risks that have poor project information management at their root.[1]

A PIX Protocol is a set of rules that have been agreed and committed to by the client and project team that defines how information is to be exchanged on a project. A PIX Protocol can be as simple or as all-encompassing as the client or project team wish, depending on the project size, duration and complexity. Although targeted primarily at electronic information exchange it can also be developed for paper based information exchange, if desired. Research has shown that projects that develop a structured approach to information exchange can expect to save as much as 10% of the project cost from improved productivity.[2]

In order to assist clients and project teams develop their own PIX Protocol, a project led by the Building Centre Trust (under the DTI Partners in Innovation scheme) has produced the PIX Protocol Guide & Toolkit.[3] This is the culmination of six years of work into understanding and improving project information exchange and integration. The research has drawn on the expertise of a wide range of UK construction professionals who are leading edge practitioners in this arena.

The PIX Protocol Guide & Toolkit is a set of guidance notes, forms and checklists intended to help clients and their project teams develop a PIX Protocol for their projects.

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1 Further information on the PIX Protocol and related projects can be obtained from The Building Centre Trust, 26 Store Street, London WC1E 7BY, 020 7692 6209, email: trust@buildingcentre.co.uk.

2 *Production information: a code of procedure for the construction industry*, Construction Project Information Committee, 2003; available at www.productinformation.org. The report contains a useful case study on the cost benefits of using an integrated information approach in the appendix, which shows that savings of up to 10% can be achieved.

3 See www.pixprotocol.org.uk: visitors to the site can register interest and download the PIX Protocol Guide & Toolkit in full and the individual components together with the report referred to in note 5 below.

The PIX Protocol Guide & Toolkit comprises five key documents:

1. The PIX Protocol Guide: this presents the case for a PIX Protocol and provides an overview of the Toolkit and how it should be used.
2. The Client's Guide: this presents a persuasive case to the client to adopt the PIX Protocol for their projects.
3. The Client's Checklist: this document comprises a set of forms to gather information from the client in order to determine the client's information management objectives for the project.
4. The Team Capabilities Review: this is a set of forms that are used to gather important intelligence from the team on project information exchange.
5. The Project Leader Checklist: this is a concise list of actions to be agreed by the team to develop a PIX Protocol for the project.

The last four documents comprise the Toolkit and are available from the PIX Protocol web site www.pixprotocol.org.uk for project team use.

The optimum route to agreeing a PIX Protocol is where the client initiates the process by assigning responsibility for implementation to the project leader. The project leader then ensures that the Client's Checklist and Team Capabilities Review are completed and analysed so that a draft PIX Protocol can be developed. The draft PIX Protocol is then finalised in a meeting using the agenda in the Project Leader Checklist.

The Toolkit also provides alternative approaches. If desired, the client can use the Team Capabilities Review in appointing the team so that information exchange compatibility is one of the team selection criteria. For those teams short on time, the Project Leader Checklist can also be used as an aide memoir to help agree a basic PIX Protocol. Gaining agreement on just some points in the agenda can still benefit the project.

A PIX Protocol should be agreed at an early stage, ideally during the feasibility study for the project. It should also be reviewed as the project passes from design through construction to handover, as leadership responsibilities and priorities change during these phases of the project. Agreeing a PIX Protocol is good practice and makes sense. The Building Centre Trust team wish success to all those who embark on the journey.

Introduction

Research by the Building Centre Trust carried out in the late 1990s[4] showed that, despite high levels of IT capability across project teams, paper still comprised a large proportion of project communications. Figure 1 below gives an extract from the research report showing the average split between electronic and paper communications during the design phase for a selection of projects occurring during 1999.

4 *IT usage in the construction team*, The Building Centre Trust, 1999; available from the Building Centre Bookshop, 26 Store Street, London WC1.

As can be seen from the chart, the majority of communications between project team members was still predominantly paper, despite nearly everyone in the survey having advanced IT systems. Something was clearly wrong and needed further investigation.

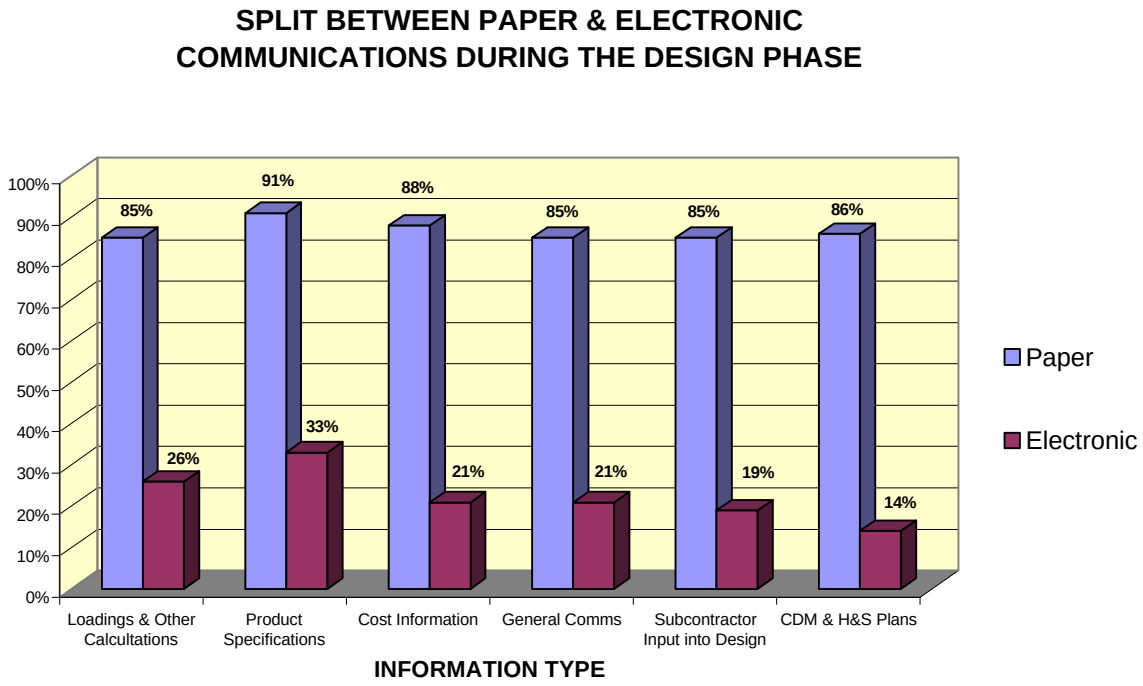

Figure 1: Communications during the design phase – results from IT usage in the construction team, Building Centre Trust 1999

In 2001 the Building Centre Trust completed a Partners in Innovation (PII) research report[5] that looked at the reasons why so much paper was still being used and examined the barriers to the sharing of electronic information on UK construction projects. The report's key finding was that project team members should address certain critical issues such as design management rules, CAD standards, agreement on common project software platforms and the basis on which they exchanged information at an early stage in the project. If this was done, then the ability to efficiently utilise shared electronic project information increased substantially, bringing significant benefits to the project and resulting in a reduction in the need to exchange paper based information.

The report recommended the development of an industry standard approach to developing a project information exchange protocol. This would be a form of guidance that would assist the client and key members of the project team make better and more timely decisions on structuring their project information systems, so that more efficient sharing of information could be achieved on the project. In 2002, the Building Centre Trust secured further funding from the DTI under PII, and with industry support has developed what has become

5 *Effective Integration of IT in Construction*, The Building Centre Trust, October 2001; available at www.pixprotocol.org.uk, see note 3 above.

known as the PIX Protocol Guide & Toolkit. This is a tool to help project teams develop their own PIX Protocol.

What is a PIX Protocol?

A PIX Protocol is an agreed set of rules for the exchange of information on a project. Each project should have its own unique PIX Protocol. This will be a negotiated document dependent on each team member's capability for generating and processing project information.

Key elements of a PIX Protocol are as follows:

- A definition of the client's information requirements, both during and at the end of the project.
- Agreement within the team on which information is to be exchanged electronically; common formats for exchange and agreed rules for reuse of electronic information.
- Alignment of design management principles for the project. This means agreeing items such as drawing origins and grids and design coordination processes to be followed.
- Alignment of document management principles such as file naming conventions and document numbering systems.
- Agreement on CAD standards to be used; this means agreeing alignment in areas such as common software platforms, CAD modelling approaches and layering conventions within CAD models.
- Agreement on standards for project communications, such as minimum speeds for internet communications, how electronic files are to be transported and agreement on maximum files sizes that can be produced for each communication channel.

The PIX Protocol as a risk management tool

Risk management issues are becoming much more important for construction industry clients. The recently published Higgs Report[6] deals with corporate governance and the role of non-executive directors. This combined with the Turnbull Report[7], means that the management of risks by adopting best practice is becoming much more important.

Firms that do not actively seek to manage their risks by following these guidelines can do damage to their corporate reputations, particularly if things go wrong. Organisations undertaking construction projects, particularly long term commitments such as under the Private Finance Initiative, are often exposing their organisations to significant risk and as such should take

6 *Independent Review of Non-executive Directors* (*The Higgs Review*), Derek Higgs, January 2003; available from www.dti.gov.uk/cld/non_exec_review.

7 *Internal Control: Guidance for Directors on the Combined Code* (*The Turnbull Report*), Institute of Chartered Accountants in England & Wales., 1999; available at www.icaew.co.uk/viewer/index.

cognisance of both these reports' recommendations. As many of the risks that arise in construction projects have poor information management at their root, the PIX Protocol can be seen as a useful tool in the armoury of risk management in the increasingly risk aware environment of today.

Why is a PIX Protocol needed?

The basic construction process as we know it has more or less successfully utilised paper communications for much of the time it has been used. However, the rapid development of electronic project information has brought both benefits and challenges to that process and many now realise that to move forward and to capitalise on the new tools and systems there is a need to reassess and redesign how things are done.

The UK construction industry comprises a large number of competing independent firms that are usually brought together to work on projects by clients who wish to construct a new building or facility. Owing to a number of factors such as competition, fragmentation within the IT supply industry, different levels of investment and lack of common industry standards, each of these independent firms will have evolved differing software implementations and systems to generate and manage information they produce on the project. This invariably means that although they can produce information efficiently themselves, they can often find it difficult to locate, interpret and utilise electronic information that has been produced by other team members.

As an example, Figure 2 below shows a set of screen shots of CAD layering methodologies used by a number of independent firms, each using their own unique 'standard' in-house approach. These methodologies are usually developed in order to optimise how information is produced and processed internally within the firm. In modern computer aided design (or CAD), layering is used to separate elements in a computer model so that different disciplines or categories of information can be worked on or processed more efficiently. Some firms can even develop hundreds of different layers to separate the elements in their CAD models.

CAD layering can be likened to a set of transparent sheets for each discipline that can be placed on top of each other to give a complete picture of the design. With modern CAD systems, significant productivity improvements can be achieved if CAD models from the independent firms that usually make up the project team (and usually provide different discipline inputs into the project) can be reused and combined into a single model. A good example is where a combined model can be used to investigate any clashes between the designs of different disciplines such as architectural, structural and services. If these clashes can be identified and rectified before the project gets to site, then significant savings can be made. Many other benefits also accrue from the development of shared models.

However, because of the variation in the way most firms in the industry construct their CAD models, unless standards are agreed and enforced at the

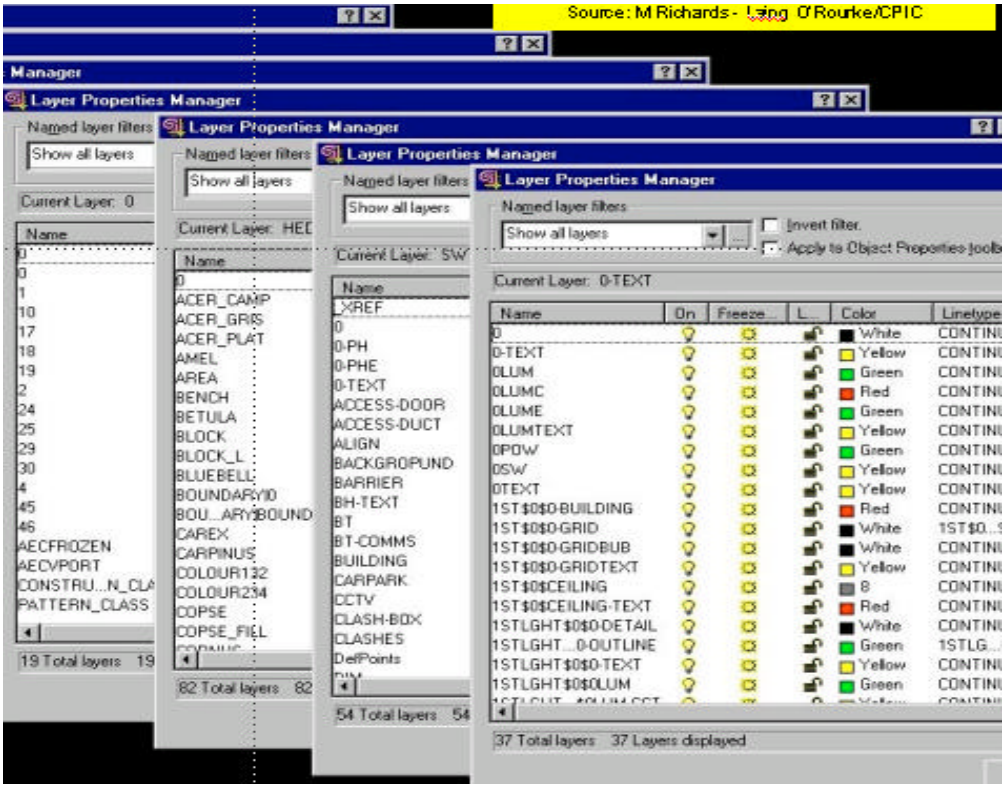

Figure 2: Screen shots of different firms' CAD layering 'standards'[8]

beginning of the project, it will be almost impossible to combine CAD models and reap the benefits identified above. What then happens is that CAD models and reap the benefits identified above. What then happens is that CAD 'drawings' are exchanged, often electronically in a non-editable format but also on paper, which are then reinterpreted. This can often result in one discipline having to redraw information from another discipline for their own use. This practice is error prone and problems often arise with keeping the information current as new drawing revisions are released. It is also an inefficient use of design team time as the work can often be done several times unnecessarily.

Figure 3 on the next page shows an example of errors that have been introduced as a result of redrawing. In the example, two different disciplines (identified as red and blue lines respectively) have produced drawn information for the same area on the project. The lack of alignment between the elements on the drawing clearly shows that errors have been introduced. For this project, problems may occur during the procurement and construction stages with attendant risks of cost overruns and delay because of these kinds of inefficiencies introduced in the design.

8 See note 2 above.

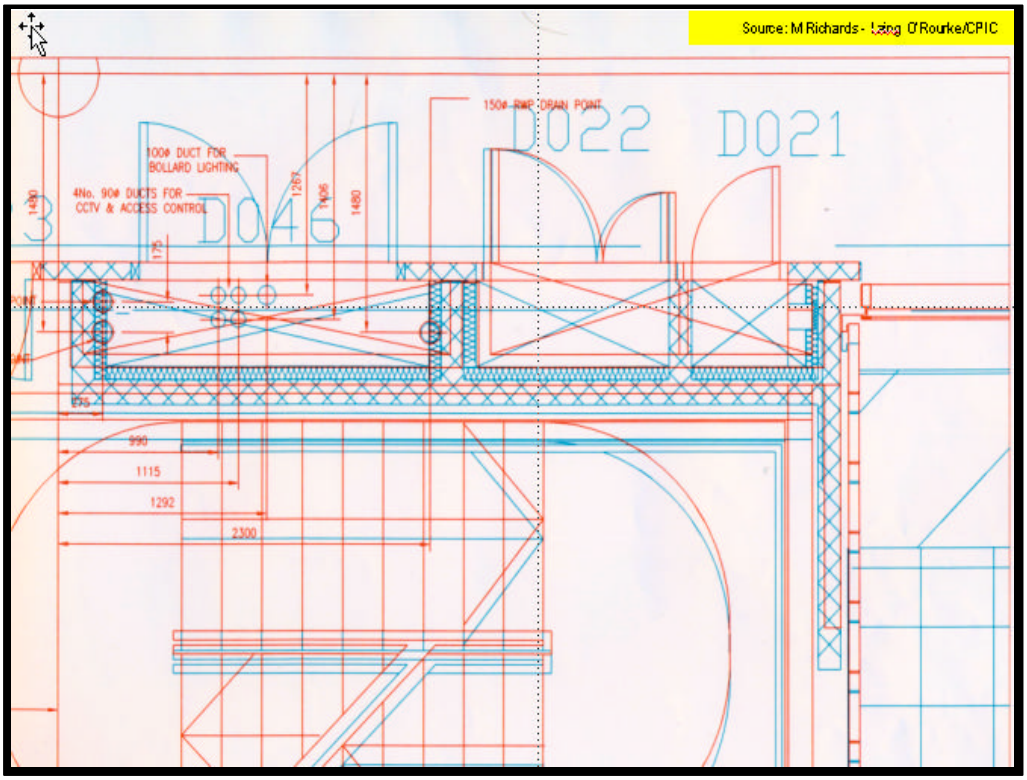

Figure 3: Errors arising from redrawing CAD drawings.[9]

The capabilities of firms making up the project team to generate, receive and process electronic information can also vary significantly. If this is not addressed, the outcome can be a kind of muddling through where it is often the weakest member of the team that inhibits the efficiencies of other team members. This lack of compatibility often means that the weakest member represents the lowest common denominator in the ability of the team to exchange and utilise electronic information.

The outcome of this situation is usually more errors and less time spent designing quality into the project. It can also cause friction within the team, as some team members have to spend extra resources sorting out and interpreting information received from others. The impact is shown in Figure 4 below.

9 See note 4 above.

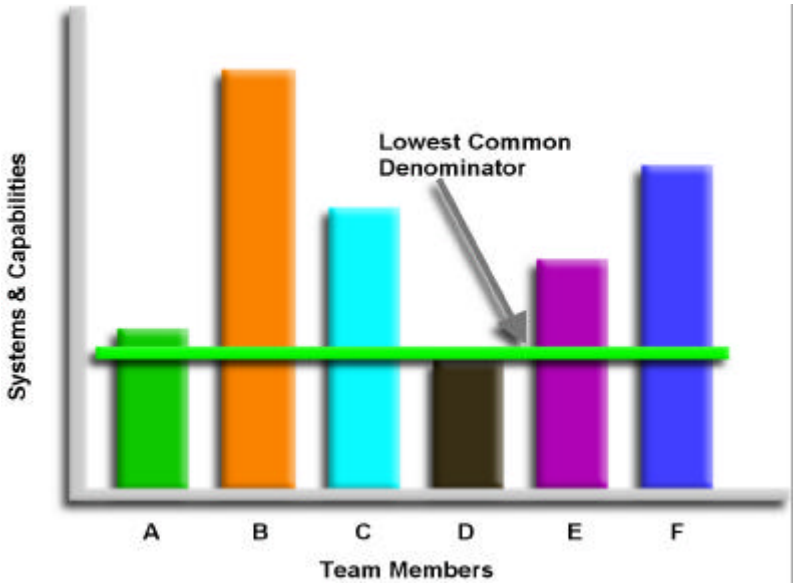

Figure 4: Typical variation of capability to process electronic project information between team members.

If the team is taken through the process to develop a PIX Protocol at an early stage of the project, then many of these areas of non-alignment can be discovered and addressed by negotiating upgrades/changes to the weaker team members. Once the team has agreed a PIX Protocol then, depending on the degree of alignment between team members achieved by the Protocol, many of the issues that occur in the sharing of electronic information between firms will be resolved. Team members will either produce information to an agreed project standard or at least have some common areas agreed and have an understanding of how other team members have arranged the information that they are receiving. As a result, the performance of the project will be improved. The impact of the PIX Protocol process is shown in Figure 5.

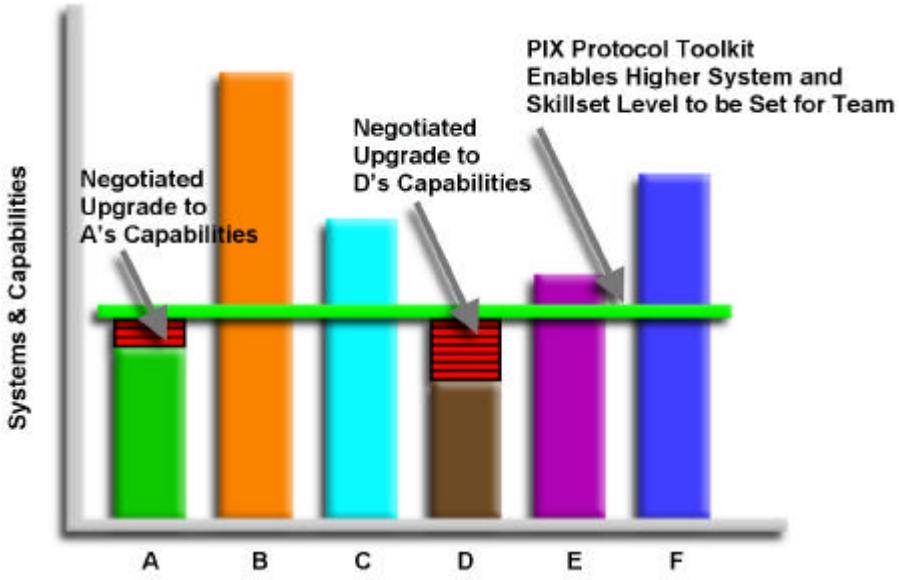

Figure 5: Impact of agreeing a PIX Protocol for a typical project

Which projects need a PIX Protocol

The PIX Protocol is primarily a tool for medium to large-scale projects where the client does not already have its own established and proven protocols. Projects of this size will benefit significantly from aligning their teams' information systems using the process. It may also be of use to clients who are interested in extending the scope of their existing protocols.

For smaller projects, there is still benefit in using the PIX Protocol process as a checklist of items to be agreed. If smaller projects can agree even some of the points identified by the process, the efficiency of information exchange will be improved, benefiting the project overall.

The PIX Protocol Guide & Toolkit

The Building Centre Trust led project has produced the PIX Protocol Guide & Toolkit which is intended as a tool to help project teams develop their own PIX Protocol. The Guide & Toolkit are the two core components with four sub-components making up the Toolkit. This structure is shown in Figure 6 below:

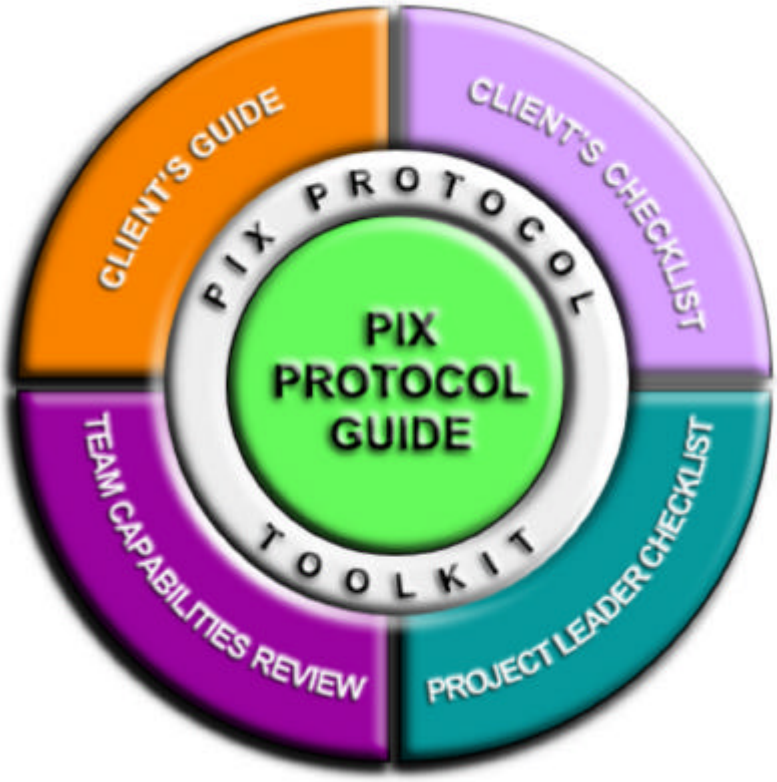

Figure 6: Structure of the PIX Protocol Guide & Toolkit

The Toolkit components are mutually supportive and play different roles in the process of developing a PIX Protocol. A brief description of the Guide and Toolkit is set out below.

PIX Protocol Guide

The PIX Protocol Guide is intended to be a master document that sets out the case for developing and implementing a PIX Protocol for a particular project. It also provides a summary and rationale for the other components of the Toolkit. The Guide also contains a glossary of technical terms.

Client's Guide

The Client's Guide provides a persuasive case for clients to initiate the PIX Protocol process for their projects. It identifies specific client benefits that can arise by agreeing a PIX Protocol and sets out how they should proceed with their appointed project leaders.

Client's Checklist

The Client's Checklist is a framework to help clients and project leaders work together to define the client's information management requirements and objectives. It also provides a framework for acquiring information on the client's IT infrastructure and software systems together with any third parties such as lawyers and property agents that are likely to require information from the project team. This helps ensure that the client and all third parties can communicate with the project team in the most effective way possible. This is likely to improve the outcome of the project in areas that are important to the client but are often overlooked by the project team, such as letting negotiations and due diligence. The Client's Checklist can also cover information that is to be delivered by the supply chain members when delivering data that will later be used for maintenance purposes. The information contained in the completed Client's Checklist will be incorporated into the agreed PIX Protocol to ensure that the client gets the information it requires both during and at the end of the project.

Team Capabilities Review

The Team Capabilities Review is designed to capture intelligence on how individual team members generate and issue information for the projects that they undertake. A set of completed Team Capabilities Reviews will highlight differences and similarities in software systems and approaches between prospective or existing team members. Based on these observations, the person responsible for leading the development of the PIX Protocol will be able to negotiate a solution for information exchange that should have less impact than an externally imposed protocol that may not take this into account.

Project Leader Checklist

The Project Leader Checklist is intended to help the appointed project leader or his or her representative through the process of developing the PIX Protocol for the project. The Project Leader Checklist is in two sections. The first part outlines the steps that project leaders should take in conjunction with their clients to define the team's requirements for project information exchange. The second part is an agenda for a team meeting to agree the PIX Protocol and sets out a number of areas that should be agreed in the completed Protocol.

How to agree a PIX Protocol

There are three primary routes that can be used to develop a PIX Protocol, depending on client and team preferences and the point in the project when the decision is made to agree the Protocol.

Two options provide for the implementation of the full PIX Protocol process in which a detailed assessment is made of the client's needs and the teams' capabilities so that an optimum Protocol can be developed. One option assumes that the team is already appointed whilst the second allows the client to asses prospective team members' ability to exchange information as part of the team selection process. The third option provides a simpler and quicker approach by proposing that the project team work through the agenda in the Project Leader Checklist to agree as many points as they can. This is suitable for smaller projects or for project teams that do not have the time to run the formal process.

These three options are shown in the flow chart in Figure 7 below:

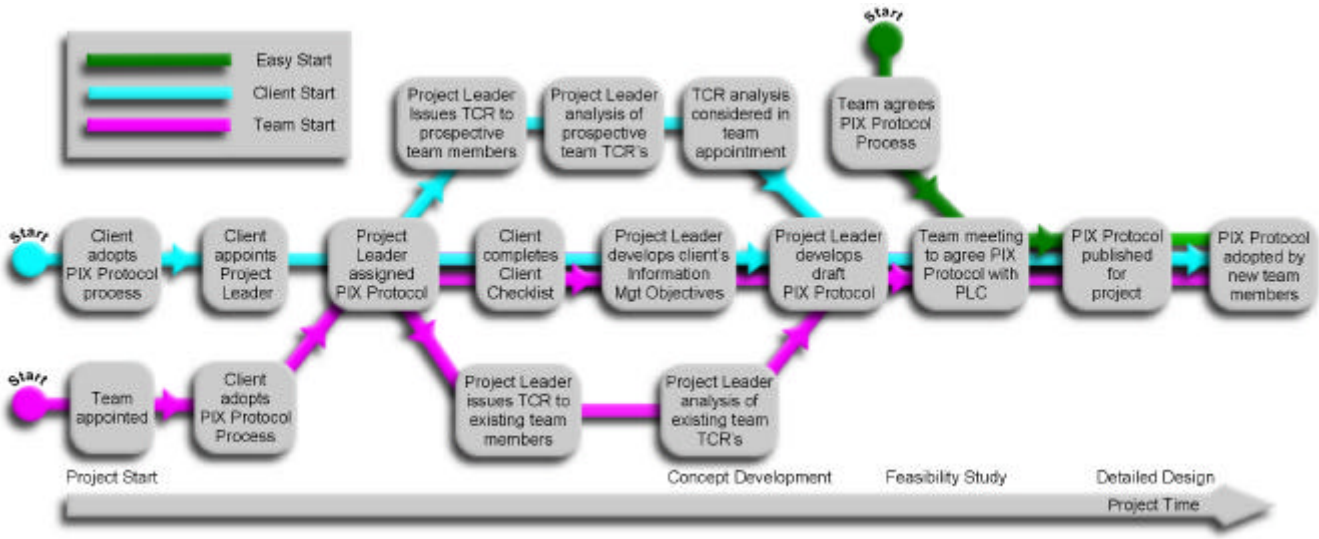

Figure 7: Process map of how to develop a PIX Protocol for a project

Team Start

The Team Start option is when the team has already been appointed and the client assigns responsibility to the appointed project leader to implement the full PIX Protocol process. The optimum point for agreeing the PIX Protocol is during the project feasibility study stage. The first stage is for the project leader, or his appointed representative, to undertake a review of the team and assess the client's information requirements using the Team Capabilities Review and the Client's Checklist respectively. The project leader will collate this information to produce a draft PIX Protocol which can then be circulated to the team members in preparation for a meeting to agree the PIX Protocol using the Project Leader Checklist.

Once the PIX Protocol has been agreed it should be published and adopted by other team members as a condition of their appointment. With this approach, the team is a given and it is up to the project leader to negotiate an agreed Protocol based on the results of the Team Capabilities Review and the assessment of the Client's Checklist. Any incompatibilities between individual team member's capabilities to exchange information should ideally be resolved at this stage if the project is to run smoothly.

Client Start

The Client Start option uses the capability to exchange information as one of the criteria for team member selection. The client appoints a suitable advisor, such as a project manager as the project leader to facilitate the implementation of the full PIX Protocol process. This includes reviewing prospective team members using the Team Capabilities Review to assess the client's information requirements using the Client's Checklist.

Once the team has been hired, the project leader can complete the draft PIX Protocol based on client requirements and the team's capabilities. The draft is then circulated to the team members in preparation for a meeting to agree the PIX Protocol using the Project Leader Checklist. As with the Team Start option, the optimum point in the project to agree the PIX Protocol is during the feasibility study. Once the PIX Protocol has been agreed it should be published and adopted by new team members as a condition of their appointment.

With this approach, the team is more likely to be in a good position to exchange information effectively, particularly if the adoption of the PIX Protocol is made a condition of the appointment contracts. This would create a legal obligation and again, appropriate legal advice should be taken in putting the appointment together. It is important, however, that the team 'own' the PIX Protocol and a project manager should avoid producing the Protocol in isolation.

Easy Start

The Easy Start is a simpler option and only uses the last three steps of the PIX Protocol process. With the team already appointed and the project running at an early stage, again preferably during the feasibility study. The team agrees to implement as many points as possible in the agenda in the Project Leader Checklist. This can be done at a single meeting, with or without preparation, and should result in a number of improvements in project communications. If there is to be no further development of the basis of exchanging information, perhaps during the construction phase of the project, other team members joining the project should adopt the PIX Protocol as a condition of contract. This would create a legal obligation and again, appropriate legal advice should be taken in putting the contract together.

Whichever route is adopted, involvement of the client in either initiating or supporting the process will pay dividends for the project. The PIX Protocol process gives clients and their teams the flexibility to choose the best route for their capabilities and preferences.

Benefits to projects

Projects that agree a PIX Protocol will accrue the following benefits:

- Research has shown[10] that projects that are able to agree and effectively implement common project standards for information production such as a PIX Protocol can save up to 10% of the project cost from improvements in design efficiency and a reduction in errors on site.
- Greater clarity in information exchange. Team members will spend less time searching for information and interpreting how that information is structured before it can be used on the project.
- Because of the greater clarity in how information is to be produced and exchanged, the risks associated with poor information management such as errors and delay will be reduced.
- By agreeing common baselines for drawing production, drawings and CAD models will be more interchangeable and ensure that successive issues of drawings will more accurately relate to each other.
- More reuse of project information. This will reduce the practice of redrawing and re-keying of information already produced by other team members because it can not readily be used in the available format. This will lead to fewer errors and more time freed for designing quality into the project.
- More effective communication of information. Team members should be able to exchange information electronically through agreed channels avoiding being hampered by team members with inadequate internet connections and having to deal with overly large file sizes.
- The quality of information produced for clients will improve leading to more effective completion and ongoing maintenance of the facility.
- By accruing the above benefits the project should be delivered with more cost certainty and within the planned budget and timescales leading to greater client satisfaction and kudos for the professional team.
- Greater clarity in the production and use of information amongst the team will reduce risks of disputes.

Evolution of the PIX Protocol through the project

The recommendations for developing and agreeing the PIX Protocol focus primarily on the critical early stages of the project. Achieving good alignment of production information standards and methods at this point makes the design and specification stages run much more smoothly. As the project moves to the construction stage, a well specified PIX Protocol will help when the contractor starts to take a more prominent role, particularly if there is a decision to use a project extranet.

10 See note 4 above.

At this point there will be a change in leadership in the project team and the PIX Protocol may benefit from reassessment. The same situation may occur at handover of the project.

Contract issues

An issue that will exercise many who advise clients on the management of risk and protocols in general will be how to implement a PIX Protocol on a project. Should it be incorporated into the contract or should it be advisory, perhaps as a best practice approach within a partnering arrangement? If it is not incorporated into the contract, then it is possible that some on the project will pay lip service to the PIX Protocol's requirements and this may mean that the project will run at the lowest common denominator in terms of information exchange. As a result, many of the anticipated benefits will not be achieved. This is an important issue that needs to be addressed early on in the project by the client and their advisors.

The PIX Protocol Project Leader Checklist recommends that the PIX Protocol be made mandatory for all members of the project team. At least in this way, higher levels of compliance are likely and within this framework there is an avenue for dealing with those who are not prepared to work to the required standards.

However, if the PIX Protocol process is applied after the appointment contracts are in place, then it is likely to become more difficult to persuade team members to change the way they produce and communicate project information as the project proceeds. In this instance, a negotiated, less complete development of a PIX Protocol may be the best option. This would deliver mutual benefit but with less disruption to firms' existing information production plans.

How to move forward

The next steps will depend on which route the client and project team wishes to take. The Easy Start option would just involve running through the agenda in the Project Leader Checklist to try to agree as many points a possible. The Team Start and Client Start options will depend on the client and how far advanced the project is in its cycle. If the team is largely in place, the Team Start is the correct option to consider. If the client wishes to be selective about the team then the Client Start option can be used. Each option will involve a detailed assessment of both client and team skills, capabilities and needs and should be given enough time to enable the relevant information to be gathered so the best decisions can be made.

Conclusions

There is much to commend clients and their project teams to develop and agree a PIX Protocol for their projects. By implementing a PIX Protocol projects can save up to 10% of their capital costs which can represent a

considerable saving for a small amount of preparation and forward thinking on the project. Even agreeing some of the points in the Protocol process can produce savings for smaller projects and those that have already started without planning a formal approach to information management. The spin offs from improved risk management can also be valuable, particularly in the current era of a more demanding corporate responsibility environment.

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'The object of the Society
is to promote the study and understanding of
construction law amongst all those involved
in the construction industry'

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