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The Effects of Project Extranet Software on Project-wide Communication Patterns

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ABSTRACT

This working paper describes an ethnographic study of the participants in a major office building project who were early adopters of a project extranet solution for exchanging project data and decisions. The extranet solution was provided as a hosted service by a software vendor. Participant observations and interviews reveal that the system provided some useful functionality, but failed to recognize and address some significant limitations in both extant communications technology and in the work culture of project participants. The resulting workarounds that project participants engaged in to address these gaps created extra work and some annoyance, particularly for employees of the general contractor on the project, who had an office with real-time Internet connections and computers on the site. Modern communication technologies such as wireless personal digital assistants can address some of the technological limitations of the project extranet implementation described in this working paper. However, the tendency of project participants to short-and in the time cut the system with direct person-to-person phone calls when they were facing really urgent requirements for decisions is likely to remain an issue for today's adopters of such technology.

KEYWORDS: Ethnographic study; project extranet; communication technology; new technology adoption; management of technology; work, technology and organization; organizational behavior; project management; construction; decision-making.

INTRODUCTION

The effect of computers on society as a whole is difficult to miss. There are few, if any, fields in which computers have not made a significant impact as they are used in everything from cash-registers to cars to nuclear-reactors. The effects of these uses have been hypothesized widely. Some feel that computers are an invaluable tool allowing us to model and understand things that would otherwise be beyond our computational power, or sparing us the tedium of performing repetitive tasks day in and day out. Others take a more pessimistic view that computers are a control mechanism, allowing managers to observe and monitor their subordinates and exert more influence than might otherwise be the case. That said, what is typically missing is analysis of the actual effects of introducing new computer-based technology into the work environment, a gap that this research hopes to partially fill.

The technology whose adoption we observed was a project extranet service, intended to facilitate communication among all of the participants on a construction project. The system was intended to provide a more concrete and visible responsibility and audit trail to aid in the tracking of issues and identification of bottlenecks in project communication. Intended to dramatically improve the existing communication patterns the system was designed to be integrated into the existing workflow providing support without dramatically changing the ways in which project members communicated in the past. What we hope to provide is an understanding of the attitudes of project members towards the adoption of the new technology, the ways in which the technology was actually utilized, and the effects it had upon the existing communication patterns.

Nature of Research

The research conducted was based on ethnographic methodology, as typically found in the field of anthropology. To best understand the situation into which the technology was being introduced, a series of site visits were conducted over the course of the research. In some cases these took the form of observations, in which members of the research team sat in on mechanical, electrical and piping (MEP) meetings and observed the interactions and discussions that occurred. In addition to the information gathered at these observations, the repeated presence over time of the observers served to increase the comfort with which those on site interacted with each other in front of the observers, as well as their interactions with the observers themselves. The researchers observations were based, in part, on the model of participant observation, in which an observer becomes a working part of the group he or she observes in order to better understand its dynamics. Given that this was a working site, the researchers themselves could obviously not contribute, but their continued presence over time served to make the members of the MEP feel more relaxed and thus more candid while being observed.

The observations were augmented by interviews carried out both at the job site and the home offices of the people involved. These interviews allowed for more in depth and focused discussion on particular topics that had proven to be important. Traditionally, an ethnographic interview is carried out as part of a repeated series of interviews with the same person, allowing for the creation of rapport over time. This length of time is also critical as it allows the interviewer to allow the interviewee to direct the interview, thereby identifying that which he or she feels is the most important and interesting topic for discussion. Furthermore, this type of interview greatly reduces the likelihood that the

interviewer biases the interviewee through leading, or other kinds of non-neutral questions.

Given the time constraints imposed by the research project as well as its scope, however, conducting an extended series of traditional ethnographic interviews was not possible. Given the large number of individuals to be observed and the time allowed for this body of research, it was not feasible to conduct more than one or two interviews per person. Consequently, the interviews were of a more directed nature, though every effort was made to ensure that the respondent was not being biased.

SETTING

Project Organization

The organization of the Fin. Co. III project can be divided into three main subgroups. First, there is the Owner's organization, which includes Fin. Co., their construction representative Rep. and Company, the project architects and their consultants, and other entities that have been contracted directly with Fin. Co. The second organizational group on Fin. Co. III is the General Contractor's organization, headed by GC Co. Also included in this organization are the specialty contractors and suppliers, who have been contracted as subcontractors to GC Co. In some cases the subcontractors themselves subcontract to subcontractors, consultants, and suppliers who themselves are not directly connected to GC Co. The third organizational group consists of regulatory agencies.

Somewhat outside the basic structure outlined above lies Software (SW) Co., a subcontractor, who performs a rather atypical role. SW Co. provides project management assistance, affecting not only the owner's organization, but the general contractor's organization as well. Where SW Co. would fit in a traditional organizational structure is unclear, but for the sake of consistency with external models, it will be considered a separate unit, not held within either the owner or general contractor's organizations. To better understand the organizations involved in the project, we provide a brief background on the major actors.

GC Co., a wholly owned subsidiary of General Inc., is a 110 year old, regional general building contractor. Ranked in the top 10 among California contractors in building sales volume by Construction Link in August 1998, GC Co.'s annual volume is

approximately $500 million. They have several ongoing building projects in the Bay area, a number of which are currently using the SW system.

The subcontractor's organizations are comprised of all sizes of companies. The primary mechanical, electrical, and plumbing (MEP) contractors are among the largest specialty contractors in the Northern California, while the building steel contractor has one of the best reputations on the West Coast. GC Co. has worked with all of the major subcontractors on numerous occasions, maintaining ongoing relations with them. Looking at the various smaller subcontractors and suppliers, one finds a greater variation in the level of sophistication than was the case with the primary subcontractors. Some have extensive and broad experience while others are very narrow in their focus and project experience.

Also found within the general contractor's organization are the material suppliers who supply materials either to subcontractors or directly to GC Co. For the most part suppliers provide specialty materials on a supply and install contract basis. Outside of these organizational boundaries exist several agencies, mostly of a regulatory nature (e.g., Cal OSHA, Bay City Building and Planning, Fire Department, Pacific Gas & Electric). Interactions with these agencies is intermittent, largely limited to the issuance of permits and the negotiation of tie-ins with existing power and gas lines.

Social Categories

Within the jobsite, social categorization and prestige typically arise in one of three ways, either through company and title, through job function, or through informal power. Company and title prestige arises from the official contractual hierarchy of the jobsite. It is this source of prestige that places the general contractor above its subcontractors. Job

function prestige typically relates to the scope of work and size of the contract or contractor. In addition, some highly specialized or dangerous tasks have high prestige relating to the danger or their possible magnitude of impact to the project schedule. Informal power-prestige results from "key member" positions in which the "key member" has a position of knowledge or power in the informal organization. These different types of prestige interact to form a prestige pyramid in which prestige is, in actuality, quite well defined.

At the top of the prestige pyramid is GC Co., largely because of their title. Second are the large and well-established Mechanical, Electrical, and Piping (MEP) subcontractors. They have substantial say in the project execution with respect to performance of the work. Further, they have second-tier subcontractors, which enlarge their sphere of influence. At the lowest prestige level are small specialty contractors or suppliers, especially those who supply components that are not schedule critical (e.g., the awning supplier, the electric gate installer).

Within an individual contractor's ranks, there is a hierarchy typically relating to responsibility, decision dependency, or years of service to the organization or in the industry. The project manager is usually at the top, followed closely by the site superintendent. The field support personnel (e.g., secretaries, clerk, office helpers, field foreman) follow therefrom. The Fin. Co. III hierarchy at GC Co. roughly follows that found in their organization chart, except that D, the Project Superintendent, is the most prestigious of S's subordinates (sometimes functioning as an equal or superior when it comes to specific field operations issues). The rest perform support functions to whoever requires the service.

Work Environment

The work environment is typical of many construction site located within city limits. It is strictly defined by a construction fence that runs to the curb. Much of the site is dirt, unless gravel has been placed in order to control dust. Most of the contractors use temporary offices (usually trailers) that are rented or owned by their companies. Of these trailers, many, but not all, have a phone line. They are usually dirty, drafty, noisy, relatively disorganized, high traffic areas, sparsely furnished, often with steel furniture or desks made from plywood or old doors. They are frequently paneled and have small windows that are covered by heavy screen or bars to prevent unauthorized entry and theft. Carpeting, if present, is of the "indoor/outdoor" variety. Most personnel wear heavy boots since it is often a jobsite safety requirement.

Level of Automation

The use of automation tools in a "field office" is significantly less than in most other office environments. Overhead fluorescent bulbs usually supply lighting, and electrical supply outlets are often crowded with plugs or multiple extension cords. Given the temporary nature of the setup, power surges, shortages, or outages are frequent.

Typically, large contractors have a computer for every office worker, all of which are typically tied to an office-wide local area network (LAN). Sometimes these local networks are further tied to the corporate office via a T1 link or modem. In addition to computers, each of these offices tends to have a photocopier, fax machine, and telephones. Representatives of these contractors were observed carrying pagers or

cellular phones, some carrying both or more than one of each. In addition, those in positions of high responsibility usually carry jobsite radios that also serve as telephones (e.g., Nextel units).

In contrast, typically smaller contractors have much less automation. Usually, if they have a trailer, they have a phone, fax, and small copier, and sometimes a single, old computer that is not networked. Unlike the larger contractors, representatives of the smaller contractors do not always carry a beeper or cellular telephone.

User Sophistication

The level of sophistication with respect to automation for each class of "user" might be a worthwhile focus for further study. Many of the users of SW are computer "literate" and have a computer in their home or office. Most have had some sort of e-mail or Internet experience. A tabulation and quantification of this level of experience was not performed in this study.

Fin. Co. Site

The Fin. Co. III project is an office building located in Bay City, California. The Owner, Fin. Co., has contracted GC Co. to act as General Contractor in the execution of the project. As the project name indicates, the project is Fin. Co.'s third building in the Gotham City Campus; the previous two having been built by GC Co. as well. None of the GC Co. project personnel involved in Fin. Co. III had been involved in either of the previous two buildings. Given that Fin. Co. had contracted to GC Co. for the construction of Fin. Co. phases I and II, phase III was awarded to GC Co. without competitive bid for a guaranteed maximum price. The subcontractors, for the most part, have worked with GC Co. before, but were selected on the basis of competitive bidding.

Occupying one city block, the building itself is six stories and has its own enclosed parking garage. It occupies an approximately 20,000 square foot building footprint and will have 120,000 square feet of occupied office space. The project cost is approximately $75 million. The project broke ground in Mid September 1998 and is scheduled to be ready for beneficial occupancy in June of 1999. The building construction takes place on one side of a freeway overpass that bisects the site, while contractor trailers and material laydown areas are located on the other side of the overpass. Access to the site by light vehicle and foot occurs under the overpass. As noted above, the GC Co. trailers occupy space across the overpass from the site of Fin. Co. III. At the start of the project, this space was identified as the site of future buildings in their building complex.

She History of SW Co. / Fin. Co. Phase III

A number of versions of the history of SW Co.'s involvement in the Fin. Co. Phase III project exist, as not only each organization involved, but each individual within those organizations remembers and understands the history in a slightly different way. Such diversity in historical recollection is not at all surprising, given the political and marketing issues surrounding such decisions. Given the newness and untested nature of the technology a fear of being seen as a champion is likely to exist among those involved in the decision-making process. That said, what follows are GC Co.'s version of the history followed by that of Arch. Co, the project architect.

SW Co. was introduced by GC Co., subsequent to their use of the system on the another project in a nearby city, a "tenant improvement" project for Brother Co. The strongest proponent for the use of SW Co. was GC Co., specifically E, the original Fin. Co. III project manager. E was the project manager on the previous project, and was impressed with the potential of the system. The history of SW Co.'s use is as follows:

GC Co. was SW Co.'s first client. Despite the previous connection between the two companies, it was, in fact, the architect, Arch. Co. who "loved the idea" of using the SW system on Phase III. The SW system was seen to be a useful tool that made paper handling and transmitting significantly easier. After being shown the SW system in action, the architect fellow-championed its use to Fin. Co., consequently resulting in its introduction in the Fin. Co. Phase III project. Once the owner had agreed to the adoption of the SW system, the instruction to use it was handed down to those actually working on the Fin. Co. Phase III project as a managerial edict. As none of the individuals who would be working on the Fin. Co. Phase III project had used the system prior to the

project, those who would be involved with the project directly engaged in a series of training sessions.

The second history, told from the perspective of the architect from Arch. Co, agrees with the first in terms of GC Co.'s introduction of the SW system. Having had "a very good experience with SW Co. on previous projects," they introduced it to the Fin. Co. team as something to add to the project. Unlike the GC Co. account, according to the architect, "it was a fairly strong push by GC Co.," rather than the other way around. According to the architect, Fin. Co. was quite happy with the previous, pre-SW performance of the team, and therefore, left it up to the consultants as an option they could choose to adopt if they were so inclined. After a great deal of discussions among the consultants and architect, it was decided to try the system on a very limited basis, initially using it only for RFIs as something of a beta-test. In this history, though the final decision was left up to the consultants and architect, it was based upon the strong support and championing of the SW system by GC Co.

Through both versions of the history, a single consistent thread can be traced. SW Co. was introduced to GC Co. corporate on a previous project. E, the original phase III manager liked the system and suggested its use on Fin Co. phase III, in effect championing the system. Fin. Co., the owner, was approached with the suggestion, and having been happy with the work they had received on phases I and II, left the decision in the hands of the architect and consultants. Fin. Co. a stated that if they thought it was worthwhile, Fin. Co. would support it. The architect and consultants, having heard of the GC Co.'s (E's) championing of SW Co., accepted the use of SW Co. and consequently, the SW system was handed to the GC Co. project team as "the way to manage the

project.” In this way, championing by GC Co. employees not currently connected to the project directly created the image of GC Co. support, even though those directly connected were handed the technology as a managerial edict.

Functionality of SW

SW is a tool for distributed (onsite) project management of construction projects. Intended to be scalable, SW allows for both multiple and individual-level project management. In terms of multiple projects, SW allows users to view all currently active sites to which they have access. On the individual project level, SW provides a tool to manage information.

Based on a proprietary model of information workflow, SW provides a platform for those involved in the project to communicate and transfer data and decisions along the proper channels –- based on the aforementioned model. These users are intended to include not only the contractor and sub-contractors, but any others involved in the project –- owners, city representatives, etc.

In setting up the SW system, SW Co. project representatives meet and discuss with users to identify the way in which information flows within their usual course of business. One of a set of generic information-flow models is then selected as the basis for the specific application of SW and is then tailored to more accurately reflect the specific project's flow of information.

This reflection also includes the look and feel to which the user is accustomed. Input windows and printable forms are designed to closely replicate the traditional paper-based documents with which the users are familiar. This is intended to make the transition to the SW environment as smooth and intuitive as possible.

Entirely web-based, SW requires only that its users have network connections and web browsers than can handle scripting. The majority of data in the system is entered through web-based submission forms, with the remainder being attached files that have

been uploaded through standard web-based document upload dialogs. Given the lack of a client-side application and data format, users are expected to identify any file-format conventions on their own, external to the use of SW.

SW is intended, in part, to serve as an automation tool, eliminating the need for managing both the flow and organization of data and easing the task of keeping on top of the communication generated by a job. By automatically numbering all relevant documents and acting as a central communication tool, SW enforces a consistent numbering scheme across all system users. SW also reduces the likelihood of communication overload as it directs communications to the relevant parties, while still leaving all documents accessible to any that require them. Upon submission of a communication, the recipient's account is updated to show the communication as a new action item for him or her to address. Furthermore, by relying solely on web-based interaction, SW removes the need for keeping track of individual e-mail accounts or fax numbers for all system users.

SW provides security to users in the form of access restrictions, controlling both access to data and functionality. Users are allowed access to all publicly posted data, but communications are sent directly to the people who need them according to the information flow-model. This allows certain information not intended to be public information to remain private. Through the use of the data-flow model noted above, SW seeks to ensure that all information is sent to the relevant parties, and that no oversights occur. Access is also restricted and controlled by the owner of the system, so that only the correct parties are able to engage in the creation of certain kinds of documents or the initiation of particular forms of communication, such as approvals.

SW also provides logging and tracking capabilities that allow users of the system to track communications and identify where they currently are, and to locate any apparent bottlenecks in the information flow. All interactions with data are time, date, and user-stamped, identifying who was involved, and when the action occurred (e.g., when items are sent, received, and "read"). As this stamping includes not only the creation of information but the reading and responding to it as well, this serves to provide accountability for user actions. Given that the information on whether a document has or has not been read by a particular party is publicly available to the other users of the system, there is easily available proof of whether or not someone has accessed a given piece of data.

In the generic information flow model, SW provides functionality for the most common information transfers in a construction setting. These include Requests for Information (RFI), Permits, Submittals, Memos, Announcements, Drawings, and Meeting Minutes. In addition, SW provides the ability to upload progress pictures of the site and check weather services for local weather conditions and satellite maps.

To better understand the typical flow of a piece of information, we will track the official flow of an RFI from creation to finish. An authorized user, through the use of a web-based data-input form, creates an RFI. The user is able to attach any file in his file system to the new RFI through the use of a browser-based upload dialog. On submission of the form, the RFI is entered into the system, having been assigned the next available RFI number. The accounts of the RFI's recipients are updated to show the new RFI as a currently active action item. When they respond to the RFI, they engage in much the same series of actions as did the submitter, filling in a similar form, attaching any

required documents, and identifying recipients. At any point in time, a user of the system can look up this RFI, see the history of its transactions, and who currently has “control” of it by a “ball-in-court” designation. Due-by dates further provide users with information as to the amount of time they have to respond.

REQUEST FOR INFORMATION (RFI)

To understand the use and effects of the SW system in a specific setting, an in-depth analysis of communication patterns and content is required. Given that the implementation of SW on the Fin. Co. phase III site, is limited solely to the creation, submission, and transmission of Requests For Information, our analysis focuses on RFIs as indicative of many of the issues facing Internet-based communications as a whole. The following analysis is broken down into two sections, first a general analysis of RFIs, providing a taxonomy, and second a discussion of the particular ways in which RFIs flow, given the SW system.

What is an RFI?

RFIs are, by definition, Requests for Information. They are intended to serve as a communication medium between the subcontractors, general contractor, architects, and consultants in which answers to questions arising from the contract documents are sought. J, the project manager defined a suitable RFI as *"any question to plans and specifications. Asking about equipment models, dimensions, etc*] According to M, a plumbing sub-contractor, *"an RFI is solely for issues that will require changes to the architect's drawings, like a wall that just cannot contain what it needs to. Typically these are monetary changes as well."* J and M's statements identify the two key issues upon which RFIs typically focus, technical and monetary concerns. Quite different, the first involve questions about the actual construction process, while the second deal with issues of payment and, hence, profitability.

Understanding the content of RFIs provides us with one framework within which RFIs can be identified, separated, and categorized. Limiting one's understanding of RFIs solely to their content, however, does not provide a model sufficient to understand the role RFIs play on the job. Content, in fact, is a relatively small dimension along which RFIs differ, limited largely to differences in RFI length, level of detail, and volume of information. In order to truly understand the role an RFI plays, one must understand not only content, but intentionality: why it was created as well as the way it is perceived upon receipt.

What follows is an analysis of RFIs based primarily on the intention of the sender. The categorizations are the result of the combination and comparison of the categories identified by our informants. One such categorization was provided by J, the project engineer who summarized the various types of RFIs as follows:

> *Some RFIs are of a technical nature. They seek a clarification of contract documents or field conditions. Others are just "basic RFIs" These are administrative in nature and are documentation of directions given verbally, in a meeting or confirming the receipt of some instruction. ... Clarifications are typically to "cover your ass legally."*

J's categorization identifies two main types of RFIs: contract clarification and decision documentation. It should be noted that though these form the basis of our taxonomy, not all those involved engage in all types of RFIs. What determines the nature of the RFI generated for a given question is largely an issue of personal preference and style on the part of the creator of the RFI. H, of HVAC Co., for example does not use "cover your ass" RFIs, as identified by J. H claims that despite his learning about the

importance of documentation, *"unlike some others, H does not use 'cover your ass' RFIs. H does not generate RFIs simply to confirm discussions that he's had on the phone."*

Despite this variation in models, we have divided RFI intentionality into the following categories which will be discussed in more depth: contract clarification —- including oversights, decision documentation -– including C.Y.A.'s, information sharing, and hidden requests. We will then address a content-based taxonomy of RFIs, consisting of: hot RFIs vs. normal RFIs.

Intention-Based Taxonomy

Contract Clarification

The first group of RFIs, is the group that seems to most accurately reflect the official intention of RFIs. Contract clarification RFIs reflect places in the contract documents that are ambiguous, misleading, or appear to cause conflicts and thus require clarification. Often these confusions are due to missing details in the contract documents as can be seen in the following:

> *[N, HVAC Co.]*
> *On drawing 5-4-1 detail 1 it shows to rough-in for a future drinking fountain, please provide the rough-in information for this future fixture.*

In other cases, RFIs originate from conflicts in the contract documents that were not caught by the coordination process. For example, an RFI arose when a fire hose cabinet was identified as being placed in a stairwell, adjacent to a doorway, posing two problems. First, it was placed too close to the doorjamb to pass code, and second, the drawings also called for a fireman's phone jack to be placed in the same location, which

was clearly impossible. The core and shell electrical subcontractor thus generated the following RFI, requesting clarification from the consultants.

> *[W, Electric Co., Inc.]*
> *At each Stairwell floors 2nd-6th,card readers, Fireman's phone jack and emergency telephones are to be installed. There is also a Fire Hose Cabinet shown in the same location. Please provide direction for location of the electrical devices and the Fire Hose cabinets.*

In discussions during MEP meetings, it was determined by the subcontractors that the best option was to move the cabinet to an adjacent wall. The RFI, however, sought the advice of the consultants.

The above category should probably be sub divided: clarifications for the purpose of getting technical directions on how to do the work and clarifications for contract purposes. These could both occur in the same message but are conceptually different in ways that might impact SW use,

Oversights / "Lazy" / "Stupid" RFIs

Within the category of contract clarification RFIs, there exists a sub-category, based on the validity of the RFIs generated. Though obviously based on a subjective value judgement on the part of the recipient, these oversights or "stupid" RFIs are quite consistently identified by those recipients and form a significant and distinct grouping of RFIs. Oversight or "stupid" RFIs are those identified as resulting from oversights on the part of the RFI's creator or questions that should not really be put into RFIs in the first place. In some cases, the producer of an RFI has all the needed information on hand, but

is not aware of it. This can be the result of poor organization, misunderstanding, or laziness in looking for the relevant information. As K, an architect put it:

> *The volume of data is really more dependent on how good the documents are in the first place and then how experienced your contractor and your project engineers are. Whether they have the time and the staff to go and find their own information or whether they're the type of staff that says "hey I don't see it, it's not obvious, lets send a request for information"*

In other cases, J claimed:

> *Sometimes "stupid questions" now become RFIs because the RFI tool is available to the contractor. For example: A contractor will write and RFI asking, where should I put my trailer. I mean, it's a valid question. It just isn't an RFI. It doesn't change or clarify the contract documents.*

Comments like J's suggest that other types of questions and answers enter the RFI system due to convenience and ease of use. These will be discussed in depth in the "ease of use" section. Even so, at a point when the project had close to two hundred RFIs, only *"about ten RFIs are of the 'stupid' variety." For*

Decision Documentation

Decision documentation RFIs, while engaging in contract clarification, differ from the above by focusing on confirming discussions and decisions that were made informally. As RFIs are official documents, and part of a job's permanent record, anything noted in an RFI is preserved for future reference if needed. In this way, RFIs serve as a method of documentation, serving to make these informal discussions official.

Within the realm of decision documentation, there exist two main sub-classes of RFIs based on the intention of the RFIs sender and the perception of the recipient. Typically, decision documentation RFIs are intended to generate an entry into the formal record of the project. Often, however, they are perceived as efforts on the part of the sender, to protect against future complaints. Given this, they are commonly known as “Cover Your Ass” (CYA) RFIs.

Formal Record

In a conversation about these informal discussions between T, an electrical subcontractor, and D, GC Co.’s project superintendent, T said that often in the case of RFIs, he would just call the architect or consultant and talk to them on the phone to work through an RFI. D added that typically he would send a drawing by fax and say “what do you think of that” and the other party would accept it or make suggestions and they'd go back and forth until they reached a decision. Then, with that reached, they would write up an RFI and get the official "ACCEPTED" approval on it.

An example of this documentation can be seen in the following, in which specific information, discussed informally is provided in the body of the RFI.

> *[J, GC Co.]*
> *Please confirm the discussion between L of GC Co. and A of Arch. Co concerning the PB-10 @ G.3 line in the garage. As noted in RFI #228-1 we will increase the width of the PB-10 to 18" to allow for rebar stacking. Arch. Co.'s only requirement was to carry the new 18" width 8 feet past the face of the shear wall. After the 8 feet the PB-10 will then chamfer back at 45 degrees and return to it's original width.*

Cover Your Ass (C.Y.A.)

Within the scope of decision documentation RFIs, there exists a distinct and well-known sub-category, referred to by J earlier as “cover-your-ass” (C.Y.A.) RFIs. These RFIs, similar to other RFIs in this category in their documentation of a decision that has been made, differ in their underlying goal. Beyond documenting a decision for the future, C.Y.A. RFIs serve to provide legally-binding documentation of field-decisions in order to establish responsibility. When faced with a decision with potential contractual repercussions, some subcontractors will create RFIs stating the exact process they plan to execute even when they know that it has already been agreed upon informally. Once the architect or general contractor has accepted the RFI, the subcontractor is no longer liable for the action, and can “pass the buck” further up the chain. An example of this is the following RFI:

> *[O, Concrete Inc.]*
> *The engineer’s response to R. F. I. Number 136 was "to provide the same detail as Fin. Co. Phase I & II". Since we did not know what detail was used on Fin. Co. I & II, I have discussed the detail used with D. D said that the detail/method I described in R. F. I. 136 is what was used on Fin. Co. Phase I & II. D elaborated by saying that if we started with lightweight concrete then when we reached the area which required normal weight concrete we would make sure the pump was clear of lightweight and then switch to normal weight concrete until that area was poured and then switch back to the lightweight mix. The pour would be one continuous pour, the normal weight concrete would be commingled into the lightweight mix at the edges of the area requiring normal weight, and there would not be a formed joint required between the two mixes. Please confirm this detail/method is correct and acceptable.*

While the line between documenting decisions for future reference and covering oneself legally is fuzzy and somewhat flexible, the characterization of some RFIs as C.Y.A. RFIs is certainly utilized. As J puts it: *"Clarifications are typically to 'cover your ass legally'"* and *"I suppose they think they are protecting themselves legally."*

Ease of Use

Ease of use RFIs are defined as those RFIs that seek neither clarification of contract documents, nor documentation of a decision. Instead, in these cases, RFIs are used for other purposes, in part due to the ease of their creation and transmission. Hidden request RFIs, for example, are used in lieu of submittals, because of the ease of creating and transmitting the RFIs. Information sharing RFIs, serve solely to disseminate information to various project members, without seeking any clarification or documentation in return. Finally, similar to information sharing RFIs, social RFIs use are intended as ice-breakers, at the beginning of a project. They neither seek to gather nor convey information, only to open communication channels for future use.

Information Sharing

Unlike the RFIs addressed above, information sharing RFIs are intended not to acquire information, but to disseminate it. Where the previous RFIs asked for clarification of contract documents or for the acceptance of a proposed action, information sharing RFIs are used solely to disseminate information that the sender believes the recipients should know. S, the project manager identified them as follows:

> *There are also "information sharing" RFIs, which just lay out facts so others can see them. These are not necessarily strict requests for information.*

Information sharing RFIs, in effect, mimic the role of memos, conveying and dispersing information. The use of information sharing RFIs may, in part, be due to the limited functionality provided in the SW system. Given that only aspects of the SW system that are functional are related to RFIs, it is quite possible that information that otherwise would have been taken care of through the use of memos is being handled through RFIs. Though this would only occur if using the system to transmit and log RFIs required less overhead than faxing and tracking memo forms, this seems quite feasible.

Social

Some RFI types bounded not only by intention or content, but by time as well. This is the case with "Social RFIs," RFIs used at the beginning of a project to facilitate social interaction. K, the architect claimed "*You know they, just throw out a lot of RFIs real early to you know, to get the, get the ball rolling."* This is not to say that these RFIs must differ significantly from later RFIs in terms of content. Instead, the mere volume of RFIs early in the project is indicative of this use of RFIs. By the time the culture of usage becomes more stable, the number of RFIs has typically reduced to the level at which it will remain for the majority of the project.

Hidden Request

The hidden request RFI is an example of a type of RFI that exists largely as a consequence of the SW system. In these RFIs, subcontractors attempt, through the use of

RFIs to get acceptance of content that would otherwise require a submittal. S described these with the following comment:

> *There are sometimes "hidden requests for substitutes" which would normally be sent as part of the submittal process. They are couched as RFIs since they are assured of a quicker answer and are less strain to put together.*

Similar to the case of information sharing RFIs, the use of RFIs as a substitute for submittals may also be the result of increased ease of transmitting documents within the SW system.

Other Dimensions of Variation

As was noted earlier, in addition to intentionality, RFIs differ in other dimensions as well. Among the many dimensions of variation that may be considered, the issue of RFI timeframe was raised numerous times in our observations. The primary indication of timeframe is the indication of certain RFIs as "HOT."

Hot

The final type of RFI that was identified was the "hot" RFIs. Hot RFIs are identified as those RFIs referring to immediate contract changes or clarifications that are needed before work on the job can continue. As this is likely to result in delays and the expenses that they cause, significant attention is given to these RFIs. According to J: this is another type of clarification request. The distinction now is "stops work" or "doesn't stop work," which overlaps with stupid / not stupid because presumably a stupid one could stop work until action is taken

> *Some RFIs that are potential changes to contracts [that] can hold up a job. These would be considered "hot." These are critical and get everyone's attention and focus. They impact everyone and the answers certainly impact the field.*

There is no set method, within the SW system, of identifying a given RFIs as being "hot." Consequently, it is up to the producer of the RFI to identify it as such. For some, such identification occurs within the message body. When faced with a "hot" RFI, W of Electric Co. writes the word "HOT" across the top of the body of the RFI text as can be seen here where the body consists only of the identification, and the RFI content is contained completely within the attached document:

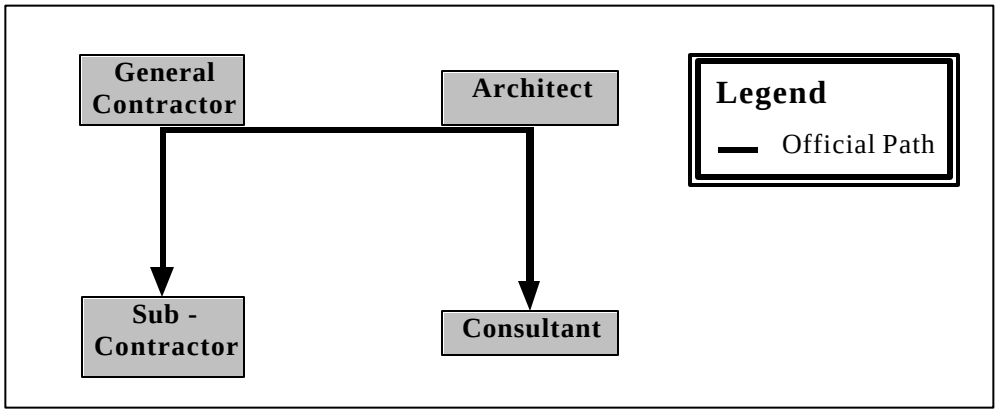
> *[W, Electric Co., Inc.]*
> *This RFI is HOT,HOT,HOT,HOT and critical to the rough in for the magnetic door hold opens.*

Flow of RFIs

Despite the existence of a fairly uniformly accepted model of the official flow of RFIs, there exists a significant amount of variation in the paths they actually follow. This appears to be the result of a series of modifications of the official base model that in some cases adds to the number of people through which an RFI must pass, and in others reduces it. These changes come about due to technical constraints as well as some short-cutting of the rigid information flow model they are intended to follow. What follows is an account of both the official information-flow model as well as the alternative models that arise in practice.

Official RFI-Flow Model

The official model of RFI-flow appears quite widely accepted and agreed upon. In interviews with the general contractor, architect, and mechanical and structural engineers, all agreed upon the same underlying model of information flow. In this model, the project can be seen as split between design and construction, with the single line of communication between them running between the general contractor and the architect. As outlined by both the structural and mechanical engineers, all RFIs generated by subcontractors are to be sent to the general contractor who then passes them along to the architect. The architect then routes the RFIs to the relevant consultants. All responses to RFIs follow the same path in reverse, with consultant responses moving through the architect and general contractor to whatever subcontractor generated the response in the first place. This results in the following communication model:



Filtering:

Inherent to this official RFI flow model is a certain level of information filtering, through which RFIs that can be answered by one of the parties along its path may stop and be answered by the first person capable of answering it. As noted above, for example, architects may opt to respond to a particular RFI instead of passing it along to the relevant consultant. R, of Consultant Co. explained:

> *On a project-wide level, the flow of information goes from Consultant Co. to the architect. Occasionally the architect can respond directly and does so, otherwise the architect passes it on to the relevant parties (usually the appropriate consultant.)*

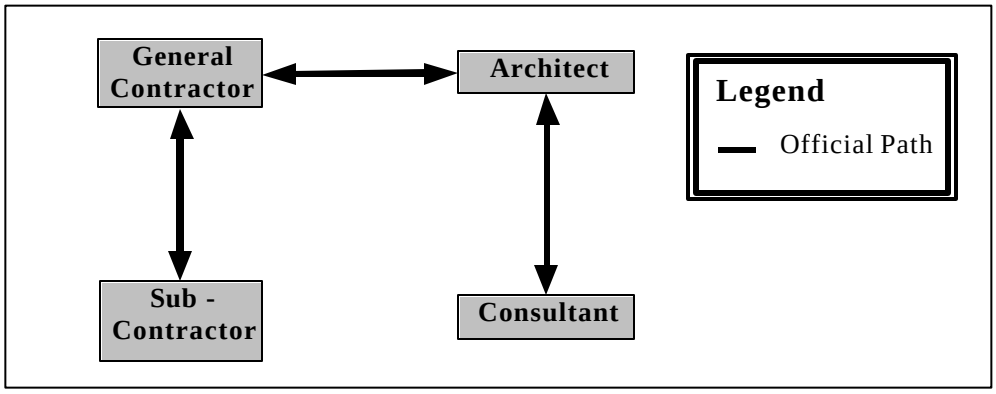
K, the project architect commented:

> *I'm just the primary contact from the architect, so any submittal, or any RFI that comes from the General Contractor has to channel through and be distributed by me and the same for any responses or any return submittals. I'm the one key checkpoint, I'm supposed to review everything, make sure the correct consultants see the information that needs to be seen. I'm just the key coordinator from the design team side*

Filtering is not limited to the siphoning off of answerable questions. It also serves to consolidate, selecting among multiple questions and answers and passing along only that which is relevant. As K further describes:

> *[RFIs] don't go directly to any of the consultants, they come to Arch. Co. We distribute them then the consultants send them back to us and we edit them. We actually may get one or two answers from different consultants. We'll pick the one that's correct, or maybe have to add additional information ourselves before we return it. So we're really a gatekeeper on the RFI and submittal process.*

This filtering mechanism results in a modification of the initial flow diagram in which information travels only as far as it needs to reach someone able to answer it.



Despite its role in the official flow of information, filtering appears to have been dramatically affected by the introduction of the SW system. J said that traditionally, in line with the filtering model, if an RFI was "stupid" he could just "*respond, hand the RFI back to the guy and tell them where to find the info.*" K corroborated this model with the following:

> *You get lots of RFIs that say "I can't find the information" and if I can go and find it in the sets, say you didn't find the dimension but it's in the building section, that's the type of information that more traditionally would be handled by*

> *the project manager. Right now we're seeing a phase locally where everybody is busy, where there is a lack of people in the field, lack of man hours to do the work, so it just depends on how well they know the drawings already. The answer's in there a lot of times, if they can find it, I think yeah, they should alert their subs.*

K, however, also noted that currently this filtering process was not currently occurring.

> *I've seen a lot of RFIs that uh, are repeated already within the project. It may come from two to three different subs but it hits GC Co.'s project engineer and it doesn't get filtered, they don't say go back, it's already answered in 95 and it just comes through because it's easy to push a button and forward it on. This one on the other hand does. "Filtering" is an important point*

Further interviews with J revealed that his view of the cause was not simply the ease of passing the RFI along, but constraints inherent to the SW system itself. While in the past J could head off items as soon as he got them, now, once an RFI is in the system, he can't do anything about it, especially once the next is in place. While he could delete RFIs, that would leave holes in the numbering, and J doesn't like that. Consequently, J just passes on whatever RFIs he gets to K.

The model also serves to reduce replicated effort, as the general contractor and architect can see the work done by the consultants and sub-contractors and make addenda to them before passing them along. As J, the project engineer explained in reference to communications to the structural engineer:

> *Everything goes through Arch. Co on the route both to and from Structure Co. This is so we can mark up each others comments without having to do all the work separately and then coordinate the versions.*

While this official model of communication provides a set of rules to govern the paths communications can take within the project, it does not accurately reflect all the paths that are actually used. Variations on the official model result from a combination of factors including both constraints limiting accessibility to the SW system as well as shortcuts that circumvent the official model. These will be addressed in turn.

Local Chains

As was noted earlier, variations differ from the official model not only through the removal of points in the RFI transferal chain, but through their addition as well. In the case of local chains, the person generating or receiving an RFI lacks access to the SW system, and therefore the ability to directly enter RFIs themselves. To compensate, the RFI is handed off to someone else, who acts as a proxy, entering the relevant information into the SW system, passing along whatever feedback is generated. These local chains can further be broken down into two categories: those that persist over time and those that are temporary, arising intermittently.

Persistent local chains

Persistent local chains are paths of communication, beyond the scope of the official communication model that persist over significant periods of time. Their lack of inclusion in the official communication model is due, in some cases, to their lying below the level of analysis upon which the official model is based. The model takes into account communication between entities on the job site (contractors, architects, and consultants) but not the communication within them. In a number of cases, local chains arise within

these organizations in order to get RFIs where they need to go. In other cases, these local chains are workarounds for technical problems that have persisted over time. Some of these local chains fit within the official model, while others do not, adding new communication paths between the entities on the job. Local chains can be further broken down into two sub categories, namely those arising from the inability of those generating and addressing RFIs to access the SW system and those resulting from intra-office communication patterns.

Looking first to access limitations, though all sub-contractors are officially required to use SW to handle all RFIs on the Fin. Co. phase III job, six of the sub-contractors do not have accounts on the SW system. When asked why those six subcontractors are not required to use the system, J, the Project Engineer and the Fin. Co. III project's *de facto* SW administrator for the job, noted that:

> *The six that aren't using it we're really not worried about because the six that aren't using it probably won't generate a single RFI between the six of them ... very small subs that are going to be here maybe two weeks at the most.*

Consequently, he felt it was not worth the time and effort to get them up and running given their very brief time on site. Given that it is impossible for these sub contractors to submit or receive RFIs through the system, someone outside their organization, with a user account, must enter into the SW system and act as their proxy. This responsibility falls to the general contractor, specifically to J. Any RFIs generated by one of the six sub-contractors are brought to J in the main trailer as hard-copy, where he enters them into the system on the behalf of the sub-contractor. Any responses to the

RFIs are given back to the sub-contractor through a combination of fax, and physical mailboxes located within the GC Co. trailer.

In addition to the six sub-contractors without user accounts, persistent local chains also arise from sub-contractors with accounts, as even though a given subcontractor may have access to the system, its field operatives may not. Far from rare, this in fact reflects the situation of the vast majority of subcontractors. During our analysis, we found only one sub-contractor, Interior Electric Co., with a networked computer in his trailer. This allows him to enter RFIs from the site himself. In all other cases, field operatives must find methods to transmit the contents of their RFI to someone with access to the SW system.

The first, and most common model is for workers in the field to call or fax questions back to their main offices, where back-office personnel enter the RFIs into the system and submit them. A similar chain then occurs in reverse when the back-office receives a response to the RFI generated in the field. H, a plumbing and HVAC sub pointed out that:

> *Within HVAC Co., RFIs are often generated in the field and brought to either M or H to enter into SW at their office. H would prefer that his guys in the field generate RFIs and then enter them into the system directly without having him or M as the middlemen.*

This initial model manages to solve the connectivity problem of field workers without altering the official communication model. As noted earlier, the level of analysis of the official model allows only for differentiation among contract-specified players, not among employees of those entities. In this case, the entirety of the local chain created to

transfer RFIs from their creators to a node of the system remains within the realm of the subcontractor that has.

In contrast, an alternative model that also appears quite common involves the use of the general contractor as a system-entry point. In these cases, field workers bring RFIs in to the general contractor's trailer, and leave them with either the project engineer or superintendent. It then becomes their responsibility to enter these RFIs in the system. J notes that often workers on the site walk into the GC Co. trailer, hand him RFIs, leave, and he then enters them in to the system. This, however, results in a shift in workload, as the general contractor is now responsible for the generation of a number of RFIs on the behalf of subcontractors. This shift of workload to another party is especially notable when contrasted with the on-site connection used by Interior Electric Co.to access the system and has been commented on numerous times. When asked about getting all the subcontractors connected in their on-site trailers, D, the Project Superintendent, noted that he:

> *likes that better because now he finds himself caught when guys come in with an RFI and hand it to him. Then when he looks down "Damn, there's an RFI in my hand" and he has to deal with it. According to D, this "pisses me off" and he would prefer it if people just used SW directly.*

This raises the obvious question of why the majority of subcontractors do not have access to SW on site. This seems to result from a combination of two factors. First, at least one sub-contractor reported significant technical difficulty getting its network set up, eventually giving up and resorting to accessing SW from its back office. Second, some claim that it would be quite difficult to get field workers to sit down at a terminal in order to enter RFIs. This is attributed largely to lack of computer skill and proficiency.

Both of these cases are affected by another contributing factor, the scope of the project itself. Given the relatively short duration that each subcontractor spends on site, the incentive to expend significant effort getting a local network up and running is minimal. H explained:

> *The guys in the field are not going to sit down at a terminal to enter RFIs into SW. Maybe on a larger job in at which HVAC Co. had more staff including secretaries as well as the computers and networking capabilities necessary, but not on Fin. Co. III.*

As noted above, local chains arise not only from restricted access to the system, but by intra-office communication patterns as well. In these cases, it results from internal structures governing flows of communication. In these cases, as those detailed above, the individual accessing SW in the office is not the person involved in the project and in the generation of and response to RFIs.

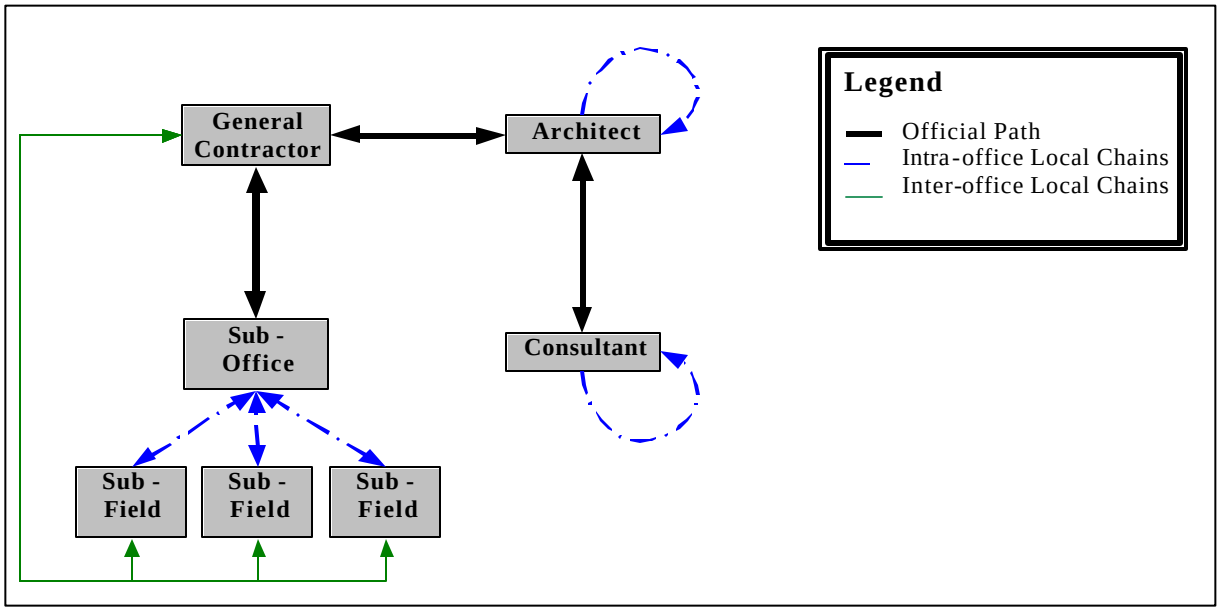
In the case of Consultant Co., the mechanical and electrical consultants, the task of checking SW has been allotted to someone other than the consultants. When new items relevant to that contractor appear within the system, the proxy contacts the relevant parties, letting them know that there is something that needs their attention. In another case, the electrical subcontractor sometimes generates RFIs that he hands off to his secretary who then enters them into the system in his stead. In the case of HVAC Co., the HVAC and plumbing subcontractor, both plumbing and HVAC RFIs went through one person. Consequently only he logged on. The heads of both sub-fields communicated to him and he passed things on as RFIs, got the responses, and passed them back. In some cases, these may not be permanent situations as in the case of the architect who due to a failure in their ability to forward documents internally, was forced to carry them over

himself. According to him " I'm printing and taking [RFIs] to her desk to get those type of questions answered."

In all these cases, the local chains arise, in part, from internal organizational structure, outside of the Fin. Co. III project. In all but the last case, they reflect the organizations' need to maintain internal hierarchies that govern communication. In the case of HVAC Co., this internal structure reflects the power structure of those working on the job. In contrast, the model identified by Consultant Co. may, in fact, have arisen out of the previous paper-based system. In the traditional fax-based system, significant time an effort was required to coordinate and manage the flow of faxes related to numerous jobs, all arriving at one central office fax. To compensate, data management positions were created, giving one person the job of receiving, logging, and dispersing all information coming in as well as gathering, collating, and sending all that was going out. This is not to say that some organizations have not adapted to the SW model, often requiring significant time and effort. U, the structural engineer noted:

> *Traditionally, when an RFI reached Structure Co., there was a designated RFI handler who took the RFI, entered it into the log, noted the due date, and then passed it on to U. U then answered the RFI and handed it back to the RFI handler, who sent her response. Now, as a result of SW, RFIs go directly to U, and she must answer them directly, which means more work for her in terms of accessing the system and transmitting documents.*

Given these findings, we must modify the communication diagram to reflect these additional paths of communication.



Temporary local chains

In contrast to the persistent local information chains described above, there exist local information chains arising from temporary technology failures that in some way prevent access to the SW system. Arising occasionally from server crashes the more common problem appears to be planned downtime due to maintenance. In some of these cases, SW notifies users with messages within the SW system. As users are unable to access their messages when the system is down, those who have not checked for announcements may be unaware of the impending upgrade until they cannot enter the system. In other cases, no notification is given and users are unsure as to the source of their inability to connect. As J, the project engineer noted at one point:

> *SW Co. has been doing a bunch of upgrades, so the system has been down. They were doing them on Monday [a holiday], when they figured 70% of the people wouldn't be working. K called me complaining and asking why the system was down.*

Regardless of the actual or perceived cause of these technological failures, they create situations in which no one has access to the SW system.

This forces the entire project to shift to an alternative method of communication and RFI transmission. The typical solution for these technology breakdowns is a return to the traditional fax-based model of communication in which all communication is paper-based, transmitted via fax. Instead of entering the RFIs they generate into the SW system, users fax the RFIs to their intended destination. This continues until SW is once again accessible, and users can resume use of the system. At this point, however, there exist some number of RFIs that exist only in paper form and have not been entered into the system. To remedy this, J, the project engineer, enters all RFIs generated off-line himself. While this return to the traditional fax-based model does not result in an alteration of the official model, it is not clear whether this changes the unofficial communication pathways that exist.

Short Cuts

One variation on the official communication model outlined above results, as noted, from project members cutting corners in the transfer of information. Given that, in most cases the target of an RFI is known at the point of its creation, the creator of an RFI will sometimes contact that target directly, broaching the subject in question often before having even created the corresponding RFI. D, the Project Superintendent admitted that

> *Often, he would just call the architect or consultant and talk to them on the phone to work through an RFI. D said that typically he would send a drawing and say what do you think of that and the other party would accept it or make suggestions and they'd go back and forth until they reached a decision. Then, with that reached, they would write up an RFI and get the official "ACCEPTED" approval on it.*

This serves a dual purpose. First, many informants noted that they preferred to work out issues via the telephone, rather than relying upon written correspondence. T, an electrician went so far as to say that "architects tend to like it better when you call. They seem to get offended by paper submissions." In such cases, the impetus to break from the official model comes from a belief that the relevant issues can be worked through more easily through an interactive verbal discussion than through a text-based exchange. I stated this point most clearly when he explained that he doesn't think that SW Co.'s text-based communication could replace face to face problem solving, as it:

> *Requires lots of give and take. Sometimes discussions take two or three iterations, for which SW is not designed. SW is fast and efficient, but not a way to solve problems.*

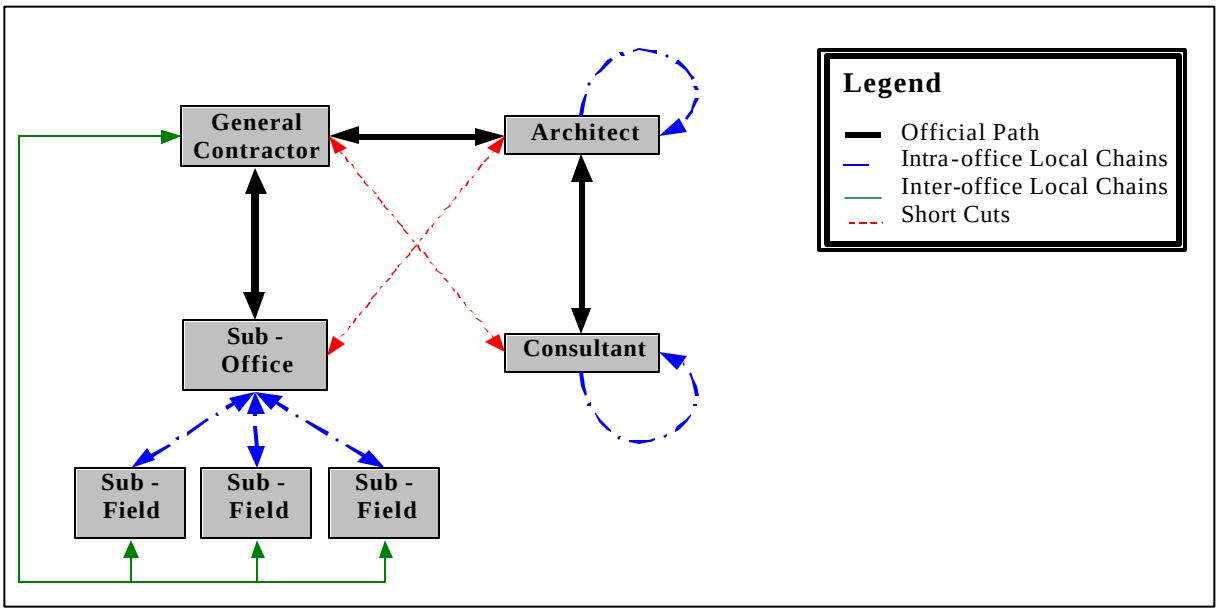
Sue, the structural consultant noted:

> *At times, people at GC Co. would contact her directly and they would discuss things on the phone or via fax. In these cases, while they spoke about the faxed drawings she would mark them up and then fax the results back. U said that in many of these cases, GC Co. would know what she wanted to do, so they would send her an RFI along with a drawing of a proposed solution. U would then respond with "ACCEPTED" if it was fine, or reject it and they would come up with another suggestion. According to Sue, however, this was the case even before SW was implemented*

This latter example hints at the second reason for utilizing short cuts, the reduction in turnaround time. In Sue's case, sending a proposed answer to an RFI allowed her to respond more rapidly than normal in many cases. In general, by contacting the target of an RFI and engaging in off-line discussions as soon as the problem has been identified, the creator of the RFI is able to begin deliberations on the subject before any RFI he could create would have reached the relevant party. As soon as the subcontractor has clarified any questions and received answers to his problem, he can begin implementing the solution while the official response is still in transit. This circumventing of the official model is especially relevant in the case of Hot RFIs, for which turnaround time is more critical than for others. In this case, the official model may be disregarded as the official series of steps requires a certain amount of time investment that may not be available to the parties involved.

Despite the benefits of short cuts, not everyone on the project uses them. M, a plumbing contractor notes that he will *"send an RFI and then wait for a response instead of communicating informally on the phone with [the RFI's target]*." This seems largely due to personal communication styles on the parts of the RFI senders, and may not reflect influence on the part of the SW system. Furthermore, there seemed to be a limitation on the scope of their use. While significant evidence of their use was found linking sub-contractors with architects and consultants with the general contractor. No evidence was found linking the peripheral actors of the communication-flow. No sub-contractors admitted to direct contact with consultants, and vice versa. Sue, the structural consultant explicitly stated that while she will at times speak directly to the general contractor, she never speaks to the sub-contractors. This model of short cut usage results in a further

modification of the information flow model proposed above in which informal communication serves to complement the official flow of information. This generates the following diagram in which the dashed lines represent informal non-SW based communication:



Effects of moving RFIs online

Perceptions of the effects of moving from the traditional fax-based method of RFI transmission to the SW system are quite varied. Whether SW RFIs are more or less developed and whether their turnaround has increased or decreased is argued in both directions. While it seems clear that there are effects, what those effects are remains subject to some discussion.

Expansion/Reduction

The first question raised is whether the nature of RFIs themselves has changed with the move to the SW system. J, the project manager argues that SW RFIs are longer than hand written ones which:

> *"Sometimes would be as simple as writing, 'See attached drawing,' and including a sketch with a dimension circled and a question mark next to it ... this is because you can't always scan in the drawing and write in the detail."*

At the same time, J argues that:

> *Sometimes RFIs are abbreviated "because of the computer." That is, since it takes a longer to go through the whole computerized RFI process, the RFI itself will be very short, maybe shorter than in a paper-based environment. This could be due to the fact that some contractors may not be comfortable typing.*

This indicates two quite different responses to a new set of required skills. In the former, producers of RFIs are forced to write more lengthy descriptive statements in order to compensate for difficulties in handling blueprints with the RFI creation process. In contrast, the latter suggests a reduction in the length of RFIs due to discomfort using the system as a whole. This latter model would further suggest increased use of informal communication methods like direct phone calls, and subsequent confirmation RFIs.

Turnaround Time

The effects of the SW system on RFI turnaround time, especially on "hot" RFIs is not agreed upon by all involved. Some believe that the system decreases the overall turnaround time of RFIs, consequently improving the handling of critical "hot" RFIs.

According to J: *"When information is requested, responses are quicker than in a paper-based system. This is better when RFIs are 'hot.'"* Others, like W of Electric Co. worry about that since the SW system due date defaults to one week, it is difficult to handle short-term RFIs. Since he cannot find a "respond by" field that would allow him to enter an arbitrary date –less than one week away—he writes "HOT-HOT-HOT" as illustrated earlier to reduce the turnaround time.

CONCLUSION

Review of Findings

This research sought to understand the environment that existed on a construction site and the effects that the introduction of an RFI-handling technology like SW would have upon it.

Looking first to the RFIs themselves, it became quite clear that there existed a variety of different types of RFIs, and that different types of RFIs were, themselves, handled differently. The system, as it was designed, did not take these different types of RFIs into account (contract clarification vs. decision documentation RFIs), and thus in some cases the end users had to improvise in order to successfully use the system (hot RFIs). Though it is not clear that redesigning the system to explicitly distinguish these different types would be effective, it certainly bears some looking into.

When it came to the system's introduction we found that, as a whole, the system was used to the extent that the general contractor mandated it but not much more. Instead of replacing the existing paper, fax, and telephone based system; SW was integrated into a complex multi-modal system that included all of those communications technologies. Though a number of factors contributed to the project members retaining this multi-modal system, the most critical appear to be issues related to the technology, as opposed to the system itself. Concerns over stability and security led to the maintenance of a redundant paper system that was relied upon heavily in times when the system itself failed. In addition, poor accessibility on the part of those on-site required complex communication-chains to compensate.

Hypotheses for future work

The findings of this research tell a rather compelling story about the difficulties of integrating a new technology into a pre-existing system. It also raises a question, the answer to which is critical to the success of SW others like it: how to bridge the gap between the office and the field. Though it was not immediately adopted universally within the office environment, the system seems on its way to becoming so. What is not clear is how to bring such technology into the field, to be utilized by people on the work site. A more in-depth study of the factors limiting the adoption and use of new technologies explicitly by those in the field stands to shed light on the situation and the potential for the successful introduction of new technologies into the field. Perhaps wireless personal digital assistants like the Palm VII or text-mobile phones would allow Internet connections between all parties on a job site. These technologies were not yet available at the time the case study was done.

The SW / Fin Co. case also illustrates an interesting design concern relevant to the world of Computer Supported Cooperative Work (CSCW). Early in the design process, both the general contractor and architect decided that the system should prevent direct communication between the general contractor and the consultant. Throughout our observations, however, it was apparent that the general contractor and consultants did communicate directly quite regularly. Given that this was not allowed within the system, they were forced to communicate via telephone. The question this raises is why it was decided that this existing communication pattern should not be modeled within the system.

In contrast, within the field of CSCW the creation of new technologies to fit a given situation is traditionally approached from an all-inclusive perspective. This means that in trying to provide a new communication tool for use in a given situation, system designers typically seek to design a tool that provides functionality for all the interactions expected to take place within the design environment. Why then, did the users of the system wish to customize the system in a way that did not reflect their daily use? It is quite possible that the system's design reflects a desire to distinguish between formal and informal communications, those that are sanctioned by the organization as opposed to those used as "work arounds." Though not answerable based solely on the data gathered within this project, this is certainly a question for further research as it has direct and clear relevance on future system designs.

Comments on Methodology

At this point, a few comments must be made regarding the methodology used in this research. Ethnography attempts, as much as possible, to immerse the observer in the interactions of those being observed. Through on-site observations and face-to-face interviews conducted over time, we were able to construct a model of the ways in which those observed interact with their environment and each other. Being present with the users as they, themselves, try to work through problems both presented and solved by the system affords us a depth of detail regarding the issues, concerns, and opinions of those being observed that is far more complete than that which could have been gathered through the use of questionnaires and server logs. Here lies the methodological strength

of ethnography, as it provides a fine-grained level of detail, allowing one to get much closer to an insider's perspective on the specific issues at hand.

It is here, however, that ethnography's most significant weakness lies as well. Given that ethnography actively seeks to understand its findings in the context within which they were uncovered, they are intrinsically quite difficult to generalize. The level to which the resultant story is both valuable and compelling is directly related to the extent to which it is deeply situated in a particular context. Conversely, as one delves deeper and deeper into the specifics of a particular situation, it becomes more and more difficult to make broader, more sweeping statements about general trends.

Consequently, the ethnographic methods that were employed in this study provide an extremely accurate and realistic account of the introduction of a new technology, the problems it created, and the ways in which those involved handled its introduction. The findings do not, however, provide a general model upon which to base future technology introductions. Ethnography does not attempt to provide a statistically valid sample, and therefore there is no guarantee that another deployment would have identical results. That said, some limited generalized insights can and certainly should be drawn from this research, as it provides a window into the perceptions, understandings, and opinions of those involved in early adoption of a project extranet service.