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Publisher's version / Version de l'éditeur:

The 5th Construction Speciality Conference of the Canadian Society for Civil Engineers [Proceedings], 2003

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June 2003

* published in 5th Construction Speciality Conference of the Canadian Society for Civil Engineers. Moncton, NB, Canada, June 4-7, 2003. NRC 45833.

Canada

5e Conférence spécialisée sur le génie de la construction
de la Société canadienne de génie civil

5th Construction Specialty Conference
of the Canadian Society for Civil Engineering

Moncton, Nouveau-Brunswick, Canada
4-7 juin 2003 / *June 4-7, 2003*

CATEGORICALLY SPEAKING: REFLECTING AEC/FM PARTICIPANTS' REQUIREMENTS IN GROUPWARE

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ABSTRACT: Groupware allows participants in an AEC/FM project to timely share relevant electronic project information at near real-time speed. One challenge of existing groupware tools is the varying information categorization needs of different AEC/FM project participants within the same groupware environment. This paper introduces initial results of a survey of several AEC/FM companies' project information categorizations. These initial results reveal differences in the ways AEC/FM project participants organize project information within each company. These differences will result in the need for a comprehensive information categorization solution when companies move their organized company-specific project information to a project-wide repository in groupware. In the future, as a result of this research, a comprehensive project categorization scheme will be introduced which would allow participant-specific views of the AEC/FM project information to be rendered.

1. INTRODUCTION

Information Technology, including the Internet, can be advantageous when used for collaboration on Architecture, Engineering, Construction and Facility Management (AEC/FM) projects (Rivard 2000). Groupware systems could be described as "single-point-access software systems [often used on the Internet] intended to provide easy and timely access to information and to support communities of knowledge workers[1] [AEC/FM project participants such as engineers, contractors, etc.] who share common goals" (Mack et al. 2001). Timely access to updated AEC/FM project information is a challenge due to the large number of participants and the large amounts of information involved in such a project. Groupware provides a virtual central location where all participants can store and access their project information as well as, when given authority, have access to designated information from other project participants. Having the Internet-based groupware allows project information to be widely accessible to all participants. In many cases, showing the true collaborative characteristic of groupware, information can be iteratively edited and/or updated by more than one project participant where each new version is instantaneously presented to the other participants involved. The cumulative changes are usually located in the same place so that a tracking of who made what changes can be easily documented. Groupware can be an effective tool for AEC/FM project participants who share the common goal of constructing a physical structure.

[1] Knowledge Workers are defined as participants who work together for "solving problems and accomplishing goals by gathering, organizing, analyzing, creating, and synthesizing information and expertise." (Mack et al. 2001)

The categorization of project information placed in a groupware system is the focus of this paper. Dividing project information into categories based on similarities between items in groups of information is a typical method AEC/FM project participants use to organize non-collaborative project information. For example, many participants group all correspondence as a category or folder. This category provides an identifiable grouping of documented communication between the author and all other project participants. Categories can be divided into a series of sub-categories, depending on the amount of information in the category and/or the presence of similarities across items of information within the category. The division of the sub-categories into sub-sub-categories, and so on, may continue if it adds value.

There is a challenge associated with categorizing project information in groupware. Project participants involved in an AEC/FM project have different roles (engineers, contractors, etc.) relative to the project, different information needs, different tasks, and therefore use different categorizations of that information. Such differences in categorization structures across project roles are evident when comparing how companies of different roles categorize their information in a *non-collaborative*, company-specific environment (see Section 4). The groupware, however, presents a single generic, central, comprehensive locale for all participants to manage their information. The challenge is to accommodate the different categorization needs of project participants within the collaborative system such that it will support participant roles and therefore prove useful and gain acceptance.

The goal of this paper is to present a preliminary analysis of an AEC/FM company survey (currently in progress). The purpose of the survey is to determine if different AEC/FM project roles use different categorization schemes. Included in this paper are the initial results of the survey including the current filing structures (categories) used by these companies to organize their project information. The companies' filing structures are then compared to determine if there are substantial differences between the ways in which companies with different roles categorize their project information. If there are substantial differences between the categorization schemes used by various project roles, it would be necessary to develop a comprehensive categorization scheme that accommodates all the needs of various project participant roles. Future work is discussed including the development of a categorization scheme, using the results of the survey, the application and refinement of the developed categorization scheme, and possible implementation of the scheme into a visualization tool for further testing.

2. CATERGORIZING PROJECT INFORMATION

Categorizing a large set of information is the process of creating a series of groups and sub-groups (categories and sub-categories) containing information items based on a quality or qualities that are common to each item of information within the group. Some familiar means of categorization are the classification of living things, a family tree, a filing cabinet, or Windows© Explorer folders.

2.1 Why Categorize?

Large sets of information are categorized to give some structure, or context (including navigational cues) to the information items in the set. Categorization supports navigation of the information set or retrieval of information items in the set. A categorization facilitates ease of browsing over a set of information and/or to locate specific information (navigating through categories and sub-categories). Without categorization, the information set may be unmanageable. Locating information or developing useful relationships between information would require a person to analyze each piece of information separately, potentially placing greater cognitive load on the person.

There can be many similarities between information items in a set of information but only a limited number of those similarities can be reflected in the categorization structure. Choosing the right categories, and therefore putting items in the information set into the right context, can determine the usefulness of a categorization structure. AEC/FM project information sets tend to become very large and are an important resource for decision-making and task completion. Given these and the competitive, budget- and time-sensitive nature of the AEC/FM industry, the need to categorize the project information usefully becomes an important issue.

2.2 Viewing a Categorization Structure

The subject of Information Visualization is a large research area and therefore is outside the scope of this paper. However, for the purpose of familiarizing the reader with categorization and due to the fact that in order to work with a categorization structure, one must see it, the issue of viewing a categorization structure is introduced.

There are a variety of ways to view a categorization structure. Likely the most familiar to many people is a hierarchy (also called a tree or an outline). Both Windows Explorer© with its folder structure and the common family tree use a hierarchy to view categorizations. Research in the information visualization of electronic information has advanced other ways of visualizing a categorization structure including Venn Diagrams, Treemaps, Nested Tree Maps (Johnson et al. 1991), hyperbolic trees (Lamping et al. 1996), and Geon Diagrams (Irani 2002). Although hierarchies may first come to mind when thinking of a categorization structure, it is important to realize this is only one of many ways to view such a structure.

2.3 Standardized Ways of Categorizing AEC/FM Project Information

There are many standards that have been developed to categorize AEC/FM project information: MasterFormat and Uniformat (MC2 2003), the Construction Index/Samarbetskommitten for Byggnadsfragor (CI/SfB): a Scandinavian standard (RIBA 2003), the Standard for the Exchange of Product model (STEP) (ISO 2003), the Omniclass Construction Classification System (OCCS Net 2003), Industry Foundation Classes (IFC 2003) and several XML (eXtensible Modeling Language) standards including aecXML (architecture engineering and construction) (IAI 2003) and bcXML (building construction) (eConstruct 2003) are some examples. The presence of so many standards shows that there is either a need for many different categorization schemes and/or there is a lack of consensus on how to categorize the information; this is an important issue in applying a categorization scheme (standard) to groupware that would be used by many industry participants.

2.4 Categorizing AEC/FM Project Information With Different Media

AEC/FM companies store and therefore categorize project information using differing media such as on paper, on computer hard drives, or on groupware. The purpose of this section is to provide the reader a context of categorization within the industry as well as to show some advantages and disadvantages of using more advanced methods of information categorization.

Information categorization can be made easier by moving from paper to electronic media on personal computers. Many companies store paper-form project information in physical filing cabinets where different cabinets, and the folders and sub-folders within each cabinet establish a categorization. The categorization structure, once created, is difficult to change for a physical filing cabinet system. Storing the information in electronic form affords greater flexibility to the categorization structure; e.g. it is possible to rearrange, add categories, or to move information items from one category to another.

Moving electronic project information from a personal computer to groupware means storing all project information in one central location (see Figure 1b) instead of it being distributed among the individual companies' filing cabinets or personal computers (see Figure 1a). The increased amount of information alone makes groupware categorization of information potentially more difficult. Additionally, the information may need to be represented in different contexts (categories and arrangements of those categories) according to the diverse roles, tasks, and resulting information requirements of each participant on a project. Yet, each participant's categorization needs to be integrated with the context required by *all* participants since all the information is located in the same place. This paper forms part of the path for developing a solution to this problem.

Security and information control is another issue for many AEC/FM companies when considering moving their project information from their own filing cabinet or personal computer to groupware; i.e. allowing other participants to access company's information. Many commercial groupware packages including Constructware (2003), and Buzzsaw (AutoDesk 2003), provide tracking features that track changes and

versions of project documentation including the original documentation provided by its author. Groupware systems also typically allow authors of documents to set permissions that limit participants' access to information including viewing and modification restrictions. The author of the information is also at liberty to store the information submitted to the groupware systems on their PC. This PC stored information provides a record of the original information in the case of loss from the groupware system.

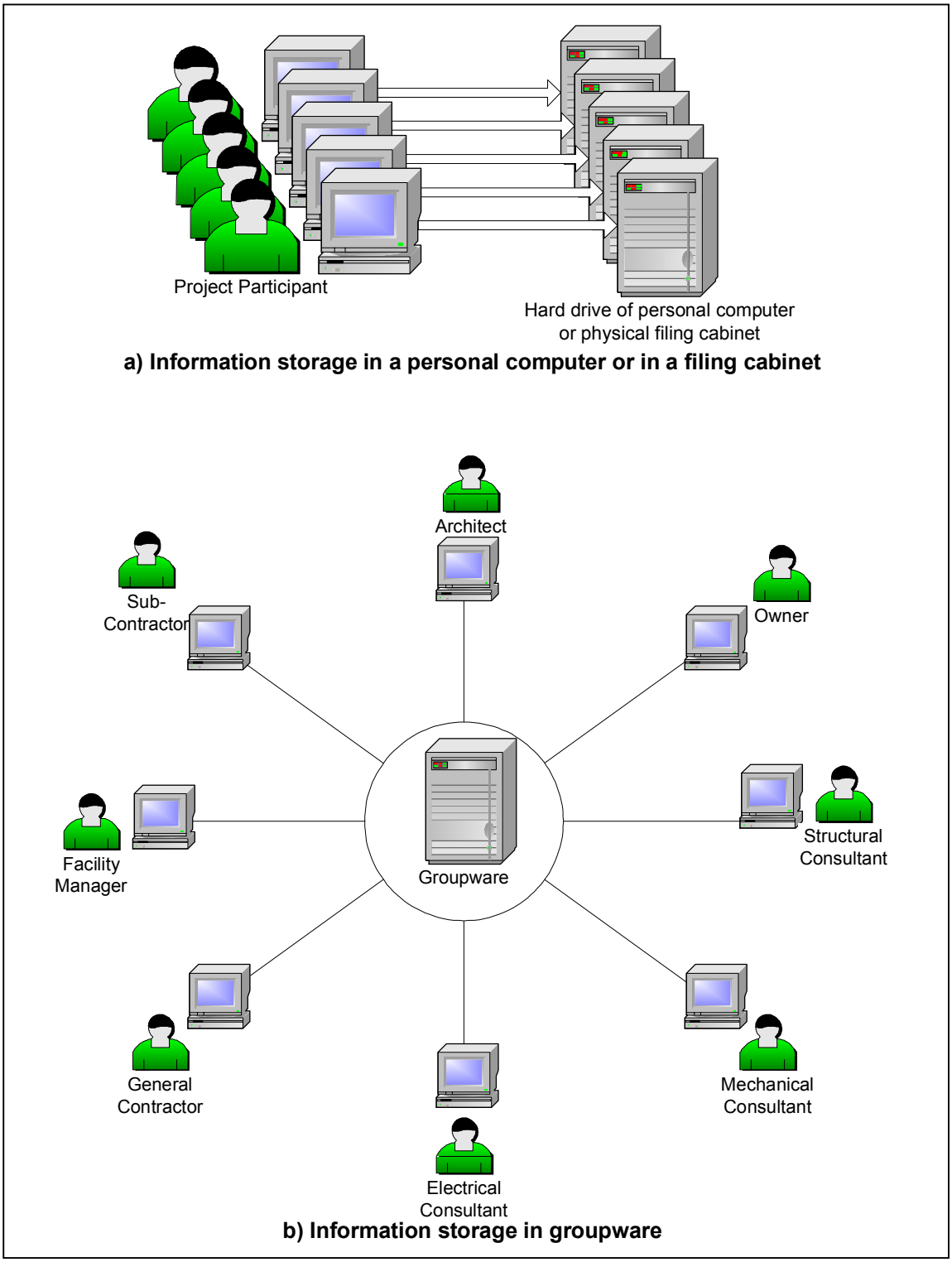

Figure 1. Storing information on a personal computer or in physical filing cabinet versus groupware.

3. PROBLEM SIGNIFICANCE

For many projects the categorization scheme used in groupware is often a single rigid structure predefined in a groupware system, such as Constructware (2003), or is implemented by one of the early project participants such as the owner or the architect. This single categorization scheme is optimal for the participant it was created by/for but may not be useful or acceptable to other project participants. If a comprehensive categorization scheme was developed for groupware that allowed multiple views to be rendered, the categorization needs of different participants might be better accommodated.

A critical mass of participants involved in a project is required for groupware to be a beneficial tool given that its advantages stem from the sharing of information. This critical mass may not be met in situations where the categorization scheme available is not flexible enough to reflect, or request, the management needs of some of the project participants. Creating different role-specific or task-specific views from a comprehensive categorization scheme may make groupware more appealing to all participants.

4. THE SURVEY

An AEC/FM industry survey is being conducted by the first author at the time of writing this paper. The main goal of the survey is to study the ways in which AEC/FM companies categorize their project information in order to determine the need for a flexible, comprehensive categorization scheme for groupware. The initial results of the survey are presented in this section and the next.

4.1 The Hypothesis Being Tested

The hypothesis central to this paper is as follows;

> There are substantial differences in the way AEC companies of different roles organize their filing structures containing project documentation.

Discussion of a further hypothesis to be tested is given in Section 6, Future Work. This hypothesis is not discussed in this paper due to the fact that the survey is not yet complete.

4.2 Survey Approach

This survey targets companies that would normally collaborate on an AEC/FM building construction project and are identified as fitting primary participant roles. Owners, engineering companies, architecture companies, general contractors, sub-contractors, and suppliers are considered the major project participant roles.

Participant AEC/FM company contact information was gathered from provincial construction associations and from contacts of the authors. This entailed a total of 35 companies spanning the various participant roles that are being targeted including 7 owners, 7 engineering companies, 6 architecture companies, 7 general contracting companies, 6 sub-contracting companies, and 2 suppliers. The companies were assured that their names will remain anonymous when results are published. The companies also have the option of receiving the results of the survey so that they can compare their categorization to the aggregate of all companies' categorizations.

The survey was sent to the companies via fax and e-mail. The same media options were given to the companies for returning the completed surveys.

4.3 Questions Posed in Survey

Figure 2 indicates the request sent to all companies involved in the survey.

Dear [AEC/FM company],

[We are] doing research on problems associated with the organization of information/documents within web-based project management systems for construction projects. Problems arise given that multiple participants would use the same system to access project documentation yet may require different means of organizing that documentation. In attempting to develop a solution, [we are] studying the ways in which different participants currently file the documentation associated with construction projects they are involved in. This is where your involvement becomes important.

****

We would be grateful if you could e-mail or fax the following:

1. A copy of the filing structure(s) your company uses to organize the folders and documentation/information associated with a construction project. This filing structure(s) may include physical and/or electronic files: if you use a different structure for each media, please send both. Please provide as much detail about your filing structure(s) as possible.

2. An indication of how your company organizes the documents within the folders in the filing structure(s) – e.g. is it:

-Alphabetical
-Chronological
-Numerical
-Colour Coded
-Other (please specify)
-No formal organization

****

One of the results of [our] research will be to find the common characteristics of filing structures for the companies surveyed. This aggregated filing structure can be used as a comparison to your filing structure. At your request, you will receive these common characteristics as well as how your company's filing structure compares to the aggregate of other companies' filing structures. Your company information will remain anonymous when sharing results with other companies.

Figure 2. Survey to AEC/FM companies

4.4 Scope of the Survey

The data collected in the survey is restricted to the six primary participant role types (architect, engineer, general contractor, owner, subcontractor and supplier) and is focused at the company-level rather than at the level of individuals within that company. An issue for future work would be to refine the scheme based on more specific (individual) roles within a company and based on specific project tasks.

The data collected in the survey is restricted to companies that would normally work on a building construction project. The companies surveyed were primarily from the Atlantic Canada region.

4.5 Survey Results

At the time of writing this paper we have received responses from 8 companies, including: 3 general contracting companies, 1 engineering company, 2 owners, and 2 architects. Information about both physical and electronic categorization systems has been returned. The level of detail of the categorization systems ranges from one-level systems with few folders to two or three level systems with multiple levels of detail.

4.6 Analysis of Results

Visualizing the returned categorization systems in a way that they can be easily compared is a challenge. This challenge is due to the large number of categories used by the surveyed companies, the multiple levels of categories within each system and the different media used to store the categories. Based on established data visualization techniques (Bertin 1981), a tabular means of visualizing the survey results has been created and is presented as Table 1. The columns of Table 1 represent each company that has responded to date, labeled according to their AEC/FM project role. The rows of Table 1 represent an exhaustive list of all named folders identified as being used across any of the returned categorization systems. Hence, a cell in Table 1 filled with a circle indicates that the company (column) uses the folder (row) in some way.

Characteristics of each circle depict relationships between a company and its use of a folder. The colour of the circle represents the media in which the company maintains the folder; either in electronic form (black), physical form (grey), or in both forms (grey with a black border). The number presented in the center of the circle represents the level within the categorization structure at which the folder exists; 1 is for a top (first) level folder, 2 is for second-level (i.e. a sub-folder), etc. The size of the circle represents the degree to which the folder label (row) used in the figure matches that of the folder label used by the company; a large circle represents an exact match between the figure label and the company label and a smaller circle represents a synonymous match. For example, Table 1 lists a folder labeled "Correspondence": 3 companies surveyed have a folder serving the same purpose which is labeled differently, e.g. "Communications". Instances such as this are considered by the authors to be synonymous. A legend in the top left-hand corner of Table 1 summarizes these circle characteristics.

Table 1 highlights the extent of the differences in the way AEC companies (according to role) organize their filing structures (project documentation). Each of the following are indications of the difference between structures (categorizations), and are discussed further in the next section:

a) The number of circles in a given row indicates the level of popularity of the corresponding folder across the companies surveyed thus far.

b) The degree in which the central number in circles across a given row differ reflects the degree to which the placing of the associated folder differs across the companies that use it.

c) Where a given row contains a large number of smaller circles, this indicates a lack of general consensus on the proper naming scheme for a given folder.

4.7 Discussion of Results

a) There are a total of 151 different folders used among the 8 companies currently surveyed and no single folder is used by all 8 companies. Only 6% (9 folders) of the folders are used by 50% or more of the companies. These 9 folders are highlighted grey in Table1 and are listed as follows:

- Change Order Proposals
- Change Orders
- Contracts
- Correspondence
- Minutes of Meetings
- Photos
- Progress Estimates
- Shop Drawings Approved
- Test Reports

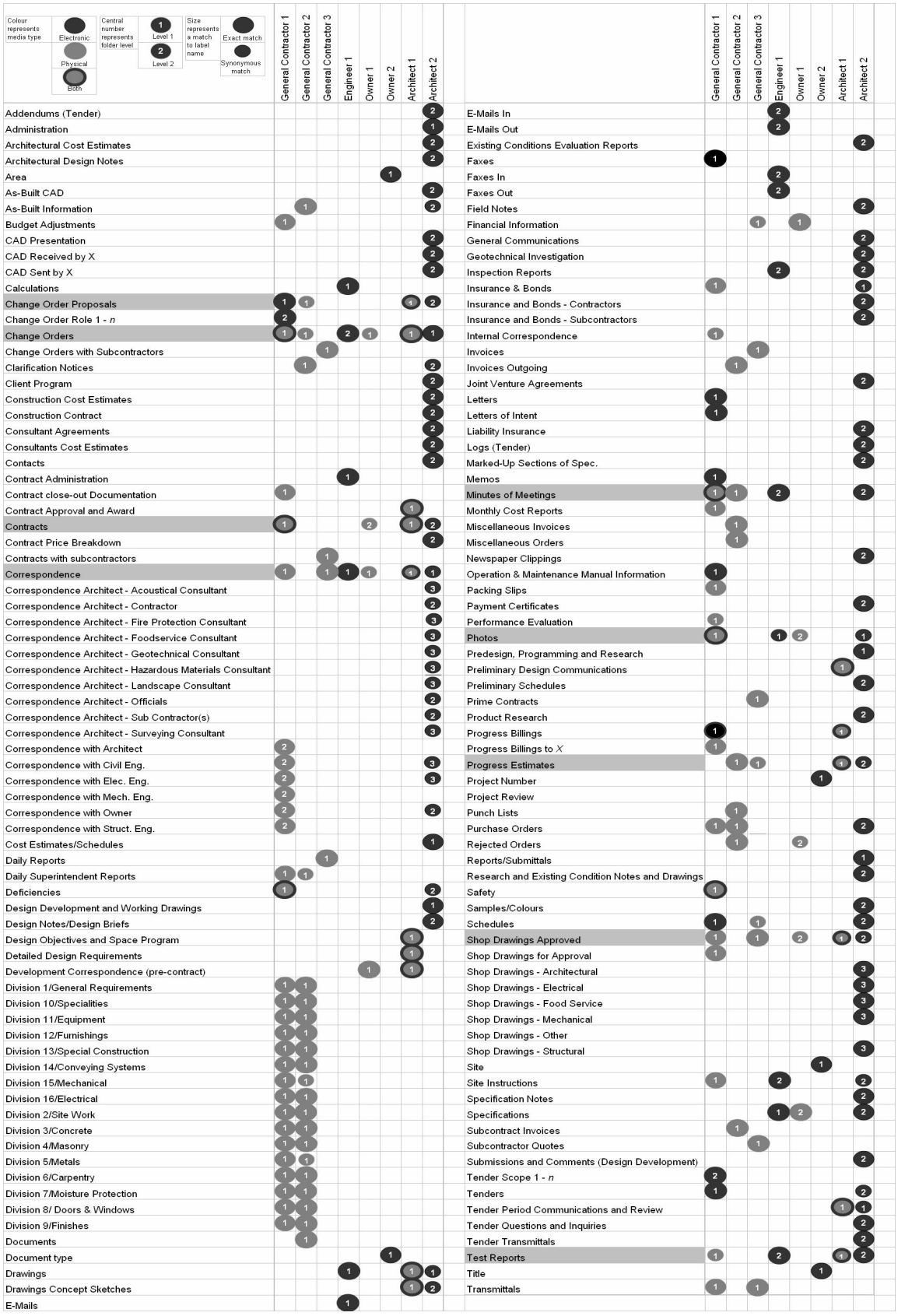

Table 1. Visualization of Categorization Systems of Surveyed Companies

b) Only 3 levels of nesting are highlighted across the entire results received and the maximum degree of difference across companies using the same folder in terms of the level at which it is situated in the categorization is 1. Therefore, this is of little significance.
c) There is little consensus in naming convention across the 9 most commonly used folders except for the folder "Minutes of Meetings" which is consistently named as such across the companies that use it.

The hypothesis being tested in this paper (the comparison of filing structures between major project roles) initially assumed that companies within the same role could be considered as a collective due to anticipated similarities between their project folder structures. The preliminary results of this survey do not support this assumption. No folders are used by all general contractors or by all owners. Ten folders are used by all architects. Interestingly, however, two of the three general contractors consistently used Division 1 through 16 from MasterFormat; this is not used by any of the other roles.

5. PRELIMINARY CONCLUSIONS

There would appear to be substantial differences in the way AEC/FM companies of different roles organize (categorize) their project information. Only 6% of the folders used by any one of the AEC/FM companies surveyed are also used by at least half of the companies surveyed. There are also inconsistent naming conventions between folders that typically contain the same information.

There are limitations to the conclusions presented in this paper. The conclusions are preliminary, based on only 8 returned surveys of the 35 expected. As mentioned in Section 4.7, there is an inconsistency of project information categorization among companies within the same designated role, reducing the ability to do role-by-role comparisons.

Despite these limitations, the preliminary results of this survey clearly indicate that AEC/FM companies classify their project information in different ways supporting the original hypothesis. Enforcing one universal classification structure of the information across all groupware participants would be problematic. Instead, a categorization scheme that could permit project information to be viewed in a context-specific manner unique to individual participants as well as in the context of the overall project information set would appear to be more useful based on these results and would ultimately lead to a greater degree of acceptance from participants required to use it.

6. FUTURE WORK

Further analysis is ongoing based on continued returned surveys. More analysis will allow the uniformity of folder use between different project roles and among companies of a similar role to become clear.

A categorization scheme will be developed following the analysis of the complete set of survey results. The scheme will provide for the collective set of all folders used across companies surveyed, organized to give an overall context to the project information set. As well, the capability to extract views specific to each project role from the categorization scheme will be realized. The categorization scheme will then be tested and refined through a series of case studies presented to AEC/FM companies.

Refining the categorization scheme based on more specific analysis of more precise roles within an AEC/FM project and of specific tasks of the roles may be required. The current survey considers the categorization used at a company level. The context of the information used for specific project *tasks* or by more specific project participants may be different.

A visualization tool will be developed to allow quick and dynamic extraction of individual role or task specific views of the information from the categorization structure. Testing of the tool will be required to assess the categorization scheme's ability to develop contextual views for the browsing and searching of the project information.

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