DELOS/NSF Working Group on

"Reference Models for Digital Libraries: Actors and Roles"

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1. Introduction

This report summarizes the discussion of the DELOS/NSF Working Group on "Reference Models for Digital Libraries: Actors and Roles".

In the Digital Library arena, neither the traditional nor the new roles of actors are clearly understood. Identification and relevance of these roles are still open questions. Conceptualizations and definitions are biased by traditional views that are not automatically transferable to the digital world, nor are they appropriate for some new emerging environments. At the same time, definitions given to new roles depend too often on the narrow, subjective perspective of a local context. The current situation makes it difficult to understand objectively the key actor/role issues that arise in individual cases, and also to perform comparative analysis between different cases.

The lack of a means of formal expression becomes apparent in several scenarios, such as when Digital Library use case descriptions are disseminated to large audiences, shared with evaluators or potential adopters, or compared by researchers. Without sufficient means to formally express the attributes and behaviors of a network of actors related by specific services there will continue to be a misunderstanding with regard to actors in terms of their requirements, designed solutions, and in the evaluation of results.

This Working Group reviewed current research and existing practice to better understand the ways in which actors and their roles are perceived within the Digital Library community; how actors interact and communicate within the scope of existing and potential Digital Library models; and the roles actors' play within the context of existing and anticipated services. The result of this investigation brought to light several issues that warrant further research and underscored the community's need of formal and objective reference models for the description of actors and their roles in digital libraries.

This report is structured in four major sections. Section two presents, in brief, references to related work (almost all of these references are, intentionally, for on-line resources). The third section describes the process and tools used and developed by the Working Group to support discussion of the issues. Section four includes several examples that illustrate the use of the tools. The fifth, and final section of the report, provides a summary of findings and a set of recommendations.

2. Related work

The identification and definition of actors and the roles they play has long been an open issue in traditional libraries, archives and museums, as described for example, in [2], [4], [5], [7], [15], [16], [17], [18], [22], [23], [25], [26], [27], [34], [35], [36] and [41].

Recent works have addressed this problem in depth, as can be seen in [6], [21], [24], [30], [31] and [42]. The problem also crops up in recent research and development as reported in [8], [9], [14], [19], [20], [37], [38] and [40]. In some cases the problem has been addressed with notable scope, such as in [1].

At the same time, it is curious to find so little mention of actors and roles in specific contexts where the issue would have a natural fit, such as [10], [11], [13], [32] and [43]. We believe that their absence is not due so much to denial of the issue as to its complexity and the fact that most Digital Library projects begin with content specifications and underlying infrastructure issues designed to address *how* the service will be provided. This system centric approach does not take into adequate consideration the communication and interaction channels that take place between different types of actors within the context of the service. Nor does it explore or seek to understand in detail how different perspectives and behaviors affect those interactions, and ultimately the ability to deliver a meaningful service.

3. The process

To illustrate the discussion of the problem we'll use a simple model and an analysis tool. The purpose of this model and tool is *not* to propose a reference model in itself, but to provide a means through which to present the issues using a format that proved beneficial to our discussions.

In addition, we agreed to the use of the following definitions.
- A *service* is an intangible benefit rendered by one party entity to another party entity. Information delivery is an example of a service.
- An *information system* is a set of services that supports electronic access to and discovery within an information base. A Digital Library is an example of an information system.
- A *Digital Library* is an information system for which the information base represents a collection of objects (digital, physical, or abstract objects), mainly used for learning and research [11].
- An *actor* in a Digital Library is a person, organization, or automaton playing a *role* in the production, dissemination, management or use of digital information.

Digital Libraries have much in common with general information systems supporting such things as commerce and entertainment; as far as actors and roles are concerned, much of what applies to digital libraries also applies to online bookstores and indeed to the Web itself. In this context it is important to note that an Actor is defined as much by its identity as by the role it plays during a specific act. It is possible for an entity to change roles from moment to moment, for example when a producer of information is usually also frequently a consumer of information. This means that either multiple roles within the same class of Actors may be assumed, or, indeed, the definitions may be changed entirely, considering other definitions of classes of Actors.

3.1 Main players in Digital Libraries: A generic use case

As a starting point, we propose a generalized model consisting of three main classes of actors that may appear in any kind of a Digital Library scenario. A generic, referential use case depicting these classes of actors and their interactions with a Digital Library is presented in Figure 1 [39].

In this scenario, a Digital Library is seen as an information system offering a set of services ("Digital Library Services"), managed by **Professionals**, conceived for the benefit of **Users**, and possibly related to external suppliers of information or services, referred to as **Agents**.

Any instantiation of these major classes of actors can be an individual, a group, an organization, or any kind of acting entity that is relevant for the use case under study (for example, automata might be actors, if that makes sense for the case). In some instantiations of the use case each generic class can also be specialized in more than one specific sub-class (for example, two examples of Agent might be Author and Editor, while three examples of Professional might be Computer Engineer, Cataloguer and Reference Librarian).
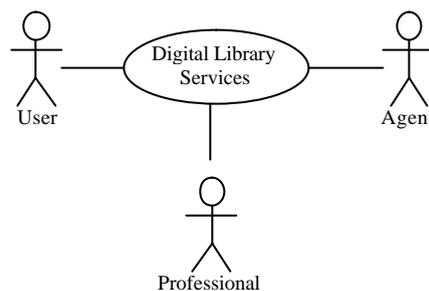

Figure 1: The generic use case of a Digital Library and its main actors.

In this User-Agent-Professional model, each class of actor represents, therefore, a particular generic role. They act with regard to Digital Library services as well as from the perspective of the other actor classes:

- A **User** is any kind of actor that interacts with the Digital Library's services in order to consult and process information made available by the library. Examples of Users can be scholars or researchers in a university library, citizens in a public library, employees in a corporate library, etc. They can be, for example, anonymous or registered, or even non-human. However, the role of Users is not necessarily restricted to just the consumer of a Digital Library. Users can also provide some useful information to enrich the services (by evaluating User requests and adjusting the services according to the User demands) as well as the digital information itself (for example, by annotating documents retrieved). In more sophisticated scenarios, Users might also interact with one another (via particular Digital Library services) in order to share digital documents retrieved from the library, or even with Agents (authors) to provide them with feedback.

- A **Professional** is an actor with authority and responsibility, directly or indirectly, for the roles and missions that take place inside a Digital Library. The main missions of Professionals include the set up, maintenance, and evolution of the Digital Library. Therefore, Professionals are those actors that have the *responsibility* to ask for new solutions and approaches, the *power* to take decisions, and the *liability* of the impacts of Digital Library's services. All of this can be done independently of the implementation and execution of decisions, which might be made by Professionals, by Agents, or by a combination of both. Examples of these actors are traditional professionals such as cataloguers, indexers, or reference and IT professionals, as well as managers.

- An **Agent** is any kind of actor that supplies information or services that may or may not be adapted by the Digital Library. Agents are traditional content providers (such as authors, editors, or publishers) or intermediary actors (such as subscription services). Agents may also play roles in the conception, implementation, maintenance, optimization, improvement or augmentation of the Digital Library's services. An example for the latter is an external reference service.

It is important to stress that the same physical entity might play several roles in the same case. A researcher, for instance, is in User mode when he/she searches in a Digital Library for literature on his/her field, and is in Agent mode when he/she contributes a paper to a journal that is selected by a deposit library to be archived.

3.2 Use cases and Relation Boards: An analysis tool

Designers of Digital Libraries usually see them as set of services that provide particular functionalities. The crucial obstacles of these system-oriented perspectives are that they narrow the views of the problem to mainly technical issues, like functionality, interoperability, and interfaces.

This system centric perception of the Digital Library doesn't give enough relevance to the communication and interaction channels between different types of actors, or to their particular views. Users, Agents, and Professionals usually differ in their perceptions of the system and, as a consequence, their vocabulary and expectations also differ. The traditional system-oriented perspective is what currently prevails and is the case represented in Figure 1. A different picture emerges, however, when relationships between different classes of actors are emphasized. Figure 2 depicts this new, more actor-oriented perception of a Digital Library: The system is no longer seen as a "black box" where interactions between actors are unclear. It is rather perceived of as a network of actors related by specific services.
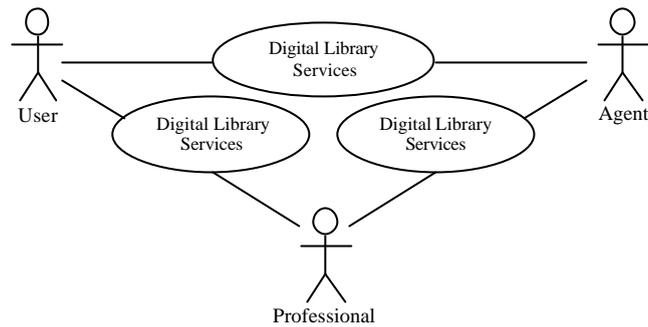
Figure 2: The generic use case of a Digital Library seen as a network of actors.

Given our three generic classes of actors, we can design a 3 by 3 matrix, referred to as the actors' **Relations Board**, where each relationship between two different types of actors is marked (here, by a ✓ character). Table 1 depicts the situation from Figure 2 as an Actors' Relations Board.

is related with	User	Agent	Professional
User		✓[1]	✓
Agent	✓		✓
Professional	✓	✓	

Table 1: The actors' Relations Board for a generic use case of a Digital Library.

The strength of the Relations Board is that it provides a formal way to specify relations among actors at an abstract level. By its template nature and through the use of a simple character for marking relationships it easily allows the identification of the special focus of a Digital Library case. Moreover, when Relations Boards of several cases are matched, it easily allows one to detect where the main research in the Digital Library field takes place and reveals (through an absence of marks) potential areas of research. .

The combination of use case diagrams and Relations Boards provides a method for describing Digital Library projects and scenarios in terms of actor classes and roles in a generic way. It forces one to clearly specify the role of an actor in a particular Digital Library case ("...is that actor an Agent or a Professional?"), think about how actors are related with the services ("...is this actor a supplier or a consumer of information?"), and identify the communication or interaction channels between different classes of actors that need to be defined in order to provide a meaningful service ("...is this a proactive service, with a push behavior, or a passive service?").

Generic modeling like this can be used to describe actual or future cases. More detailed case diagrams can be developed in which more important details of the case may be specified, by labeling relationships or by deriving subclasses of actors. For the purpose of this report, we will use this approach for simple analysis, and as a way of illustrating our discussion in the next section.

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[1] Read: A User is related with an Agent.

4. Scenarios

To illustrate our discussion of the problem, we will use four generic Digital Library scenarios, each one represented by two cases. Each scenario is intended to be related to a generic case, but viewed from two different perspectives. This comparative approach was intentional in order to make it easier to identify and point out examples of complementary or divergent issues with regard to actors. It was therefore based on these cases that we supported our analysis work.

4.1 Scenario 1: Digital Libraries for Science and Technology

The impact of the Web on scholarly and scientific communications is a hot topic. For example, core services provided by traditional journal publishers (registration, validation, certification, dissemination and archiving [29]), are being challenged by new electronic publishing models based on open access and self-archiving [12] [3]. As a result, traditional libraries and publishers (Figure 3) face new dilemmas regarding their actions and roles within an emerging market.
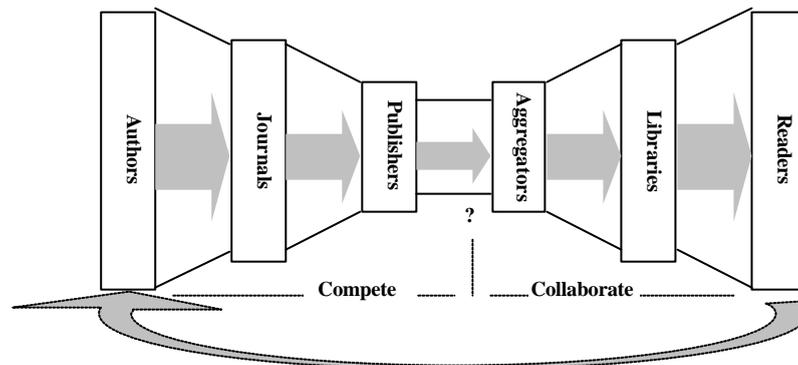

Figure 3: Digital Publishing and the strategic dilemma of the traditional publisher [28].

We detect in this scenario two extreme cases: on one side the traditional commercial publishers and on the other side the new proposals for a future free of commercial actors. In spite of all the arguments for or against the new or revised visions and models, however, it is not clear yet if we are moving in the direction of a completely new world, with the rethinking and redesign of all the models, or to end within a more complex world, with the maintenance of the traditional models in complement with new solutions.

4.1.1 Case 1.1 - A traditional case

In a traditional case, as described in Table 2, Users and Agents see the Professionals as important actors playing important roles. These Professionals play relevant roles as mediators, collecting proposals and requests from Users, as consumers (U:P), and interacting with Agents (P:A, A:P), which are represented by publishers and aggregators (A:A). Professionals are also relevant in this case because they provide, for example, services of selective dissemination of information to Users (P:U).

is related with	User	Agent	Professional

User			✓
Agent		✓	✓
Professional	✓	✓	

Table 2: Relations in *the traditional case* of the Digital Libraries for Science and Technology.

4.1.2 Case 1.2 - A possible emerging case

In a challenging case, as described in Table 3, Users and Agents don't see their relations with the Professionals as relevant. Professionals are still key actors in the scena rio, but the impact of their roles is now more ubiquitous. The case gives new priority to community building, promoting more direct relations between Users and Users (U:U, so the Users are no longer only consumers), and between Users and Agents (U:A). With a shift in emphasis to community building, Professionals now are concerned with a major new task (P:U, P:A), which requires new roles. Finally, Agents are now mainly authors (producers), and ultimately they might also become Users.

is related with	User	Agent	Professional
User	✓	✓	
Agent			
Professional	✓	✓	

Table 3: Relations in *a possible emerging case* of the Digital Libraries for Science and Technology.

4.1.3 Comparative analysis

Which model will prevail in future, if any? If both will coexist, what overlaps or divergences between them will be relevant? Substantial analysis and descriptive work focused on the multiple roles of the multiple actors involved in the processes has already taken place. The results have been promoted, however, primarily from the biased perspectives of each of the extremes. Each side has been more focused in defending its own position, than identifying and promoting mutual recognition and convergence. These problems could be minimized if actors and roles were analyzed and described in more formal and objective ways, making it easier for everyone to see with more clarity, the issues of importance that will impact the future.

From this use case analysis, we draw two conclusions:
- Approaches for digital rights management should take into account the possible multiple roles of Users and different motivations of authors.
- Emerging models are bringing new challenges to Professionals, who will have to adapt their processes to the new roles of Agents and Users.

4.2 Scenario 2: Discovery services based on harvesting

Since the early days of the Web a discussion has taken place about the pros and cons of Web indexes built automatically by search engines as an alternative to traditional human-built databases. Search engines are very effective in indexing the surface skins of the Web, but they miss the richest content hidden behind the more complex Web sites and databases, the so-called "deep Web". On the other side the relatively low cost of these engines have been making it possible to provide good services without the costs of manual cataloguing, classification, and indexing of resources. These two scenarios are represented by the same relations board in Table 4.

is related with	User	Agent	Professional
User			
Agent			✓
Professional	✓	✓	

Table 4: Relations in a resource discovery service based on harvesting *structured metadata* and *unstructured data*.

4.2.1 Case 2.1 - Harvesting structured metadata

This case represents a discovery service based on harvesting structured metadata. Participants in a service of this kind form a closed and defined environment where contractual and technical requirements are agreed upon by Agents (as content providers) and Professionals (as service providers). In this case, content providers agree to have metadata harvested through a contract with a service provider (A:P). In turn, the service provider might index or reuse the metadata in specialized databases according to the terms and conditions of the contract (P:A). As described, Users don't play a direct role in the aggregation of metadata, they do however, interact with the Professional and affect/influence the kind of added value services to be created (P:U).

4.2.2 Case 2.2 - Harvesting unstructured data

This case represents a discovery service based on harvesting distributed unstructured data. The content providers are Agents not necessarily aware that their resources are being harvested. By and large no communication between content providers and data harvesters needs to take place. However, even in these cases content providers may enter specific agreements regarding the harvesting of their resources [44][45]. Therefore, content providers implicitly agree to be harvested (A:P), even if they also express their conditions. In this scenario, the Professional defines some type of harvesting policy based on what it might know about the Agents (P:A), which, at a minimum, would include a specification of the domains to be harvested. Finally, all of this is done, taking into consideration the service to be provided to the Users (P:U).

4.2.3 Comparative analysis

Interestingly, the Relations Board for both scenarios looks the same, although the actual scenarios possess significant differences. This situation illustrates that understanding the underlying differences will be of great importance when expressing the cases for actors,

their roles, and interactions within the Digital Library service. We therefore believe that further exploration may reveal formalized ways of analyzing the scenarios with greater granularity. On the other hand, it may be of great significance to understand and appreciate the fact that significantly different cases may have the same underlying conceptual model at a high level of abstraction, and therefore, with a high probability, belong to the same global scenario.

From this use case analysis, we draw four conclusions:
- Reference models should explore and comprise formalized ways of analyzing the cases with multiple levels of granularity.
- Practical examples of the two cases might show the potential of using both structured metadata and unstructured data for resource discovery services. However, this generic scenario could be much more interesting if both approaches could be used complementarily. This is possible in controlled systems, but not easy in open environments like the generic Web, where trust and authentication are major problems. In that sense, it would be important to promote research in the development of models and frameworks for the analysis, identification, description, registration and authentication of trusted Agents, especially when these are authors, publishers or content providers in general sense.
- The previous conclusion brings to light another important issue, which is the design and development of open services for the registration and identification of those Agents [46], versus the development of closed or limited services [47].
- The development of customized services and User interfaces is a complex issue in any kind of service, and resource discovery is not an exception. This is relevant for traditional cases, but it might become yet more important for new emerging ones, where for example structured metadata and unstructured data might be used complementarily. In that sense it'd be relevant a better formal knowledge about classes of Agents, which in this scenario play roles of producers, and Users, which in this scenario play roles of consumers but also of potential producers. This might be an important research issue in itself. Formal descriptions of those actors might prove to be relevant for comparing different relations and business models, and consequently for the development of generic tools and systems.

4.3 Scenario 3: Libraries for Preservation

Nowadays everyone can be an author and his/her own publisher, at simply the cost of maintaining a Web site. The easy availability and dynamic nature of Web-based content brings with it new dimensions to the problems of preservation of information held in digital forms. New legal issues now are encountered alongside complex technical problems, making this one of the most challenging scenarios in digital libraries. For this scenario we conceived two use cases that share the same relations board, as presented in Table 5.

is related with	User	Agent	Professional
User			
Agent			✓
Professional		✓	✓

Table 5: Relations in a case of a library for preservation.

4.3.1 Case 3.1 - A conventional library collection

In a traditional deposit library Professionals define and apply a deposit policy. This typically requires direct contact with Agents (P:A) whose main roles are publisher, author, or the equivalent. Professionals, in this scenario, are heterogeneous classes of staff (P:P), who select, provide metadata, and provide access according to collection development policies and legal frameworks. Collection development tends to be highly selective, with most (A:P) and (P:A) interactions deliberately undertaken. Both physical and digital objects are in the collection. Metadata is currently human-assigned and of high quality, but it is expected to become automatically assigned as standards for metadata mature.

4.3.2 Case 3.2 - A generic Web harvesting for archiving

This example illustrates the case of harvesting online content with the development of an archive as the goal. As in the previous scenario, this Digital Library has a collection development policy. The difference is that in this scenario, automated harvesting processes primarily realize the policy. Only digital objects are in these collections. Professionals build collections upon specific policies (P:A), but generally independently of the other actors, and for the most part, collection development tends to be highly inclusive, with most of the (A:P) interactions as passive. Agents may occasionally contact Professionals to request that content be withdrawn and/or excluded from harvesting activities in the future (A:P). De-accessioning is mainly Agent-driven, and thus is unlikely to occur because of technical constraints (an optimistic view, given current bandwidth, CPU power and disk storage cost trends). Metadata is currently automatically assigned and of poor quality, but is expected to become richer as standards and automatic metadata generators mature. Due to the highly complex nature of the content, Professionals have to play new key roles, especially in the technical area (P:P).

4.3.3 Comparative analysis

 From this use case analysis, we draw three conclusions:
- The preservation of digital materials represents new challenges and requires new models, including those that encompass new roles for actors. These new roles may in fact introduce new subclasses of Professional actors in Digital Libraries, but also a potential opportunity for new subclasses of Agents. A better identification of (trusted) Agents can be an important element for decision making in collection building in exclusive scenarios. This implies that serious analysis of these cases must address not only a technical perspective, but also take into

consideration other sensitive issues such as liabilities, scopes of responsibility, legal frameworks, etc.

- An important strategy for digital preservation might be replication. In a scenario of this kind new relations between Professionals, concerning the sharing of knowledge and trust, have to be understood and defined. That requires new roles for Professionals, and again the addressing of issues such as liabilities, scopes of responsibility and legal frameworks.

4.4 Scenario 4: Collaborative Digital Libraries

A collaborative Digital Library is a user-centered system. In addition to the traditional purpose of providing resource discovery services, the system is also conceived of as providing specialized services for some classes of Users, which might range from basic alerting and selective dissemination services to complex, virtual community working spaces. In this sense the Digital Library represents a special workspace for a particular community, not only for search and access but also for the process/work-flow management, information exchange, and distributed work group communications.

4.4.1 Case 4.1 - A Digital Library for a closed community

One possible case of a collaborative Digital Library can be a system for a closed community, as described in Table 6. User participation is restricted to a specific set of identified members that might be, for example, invited by a workspace owner. In this sense the workspace is maintained by a particular actor that maintains the library, playing a Professional role (P:U), but who might be seen by the community also as a User (U:U). Also, Agents that started by simply providing content can become involved in the process as members of the community (U:A, A:U, P:A, A:P, A:A). Registration and authentication of community members is required, which might happen by invitation or as the result of a request (U:P, A:P, P:U, P:A). The workspace owner has authority to reject information submitted by community members (A:P, P:A).

is related with	User	Agent	Professional
User	✓	✓	✓
Agent	✓	✓	✓
Professional	✓	✓	

Table 6: Relations in a case of a Digital Library for a *closed community.*

4.4.2 Case 4.2 - A Digital Library for an open community

A second possible case of a collaborative Digital Library is one designed for an open community, as described in Table 7, in which the community creates the workspace itself. The registration and authentication of community members is not required or, if required, is self-made. Community members can submit information to the workspace and consul the workspace (U:U, U:A, A:U, A:A), and Professionals play "hidden" roles (it doesn't mean that there are no Professionals, of course, but just that their roles are

uniform and so the relations between multiple roles of Professionals are not relevant in this case)

is related with	User	Agent	Professional
User	✓	✓	
Agent	✓	✓	
Professional			

Table 7: Relations in a case of a Digital Library for an *open community*.

4.4.3 Comparative analysis

The main difference of these two cases regards the role of the Professional, his presents/absence respectively. Moreover, the Professional might belong to the same community as the Users and the Agents, in contrast to the traditional library case, where Professionals represent a distinctly different class of actors than Agents and Users. A further key characteristic of a collaborative system is that it might imply a continuous change of roles of the actors participating, and therefore the change of patterns of interactions.

From this use case analysis, we can draw these conclusions:

- A relevant issue to be taken into account for a sophisticated reference model is the dynamic of the system under study coming from the change of roles of actors (in both the cases of our collaborative scenario community members might be Users and Agents).
- The absence of relevant Professional roles (in contrast to the case in 4.2) implies a challenge to the definition of classes and roles of Users and Agents. This requires a better understanding of Users and Agents in collaborative systems, potentially leading to an emerging User-Agent model.
- What changes when a Professional becomes a community member? Are we facing requirements for new subclasses and roles of Professionals? What about the exposed or hidden nature of these roles? Community membership is a further relevant issue to be taken into account for the development of a reference model for actors and roles in Digital Libraries.

5. Research issues and conclusions

There is no doubt that the problem space involving actors, their roles, and interactions, is complex. As we reviewed current research and existing practice to better understand the ways in which actors and their roles are perceived within the Digital Library community, how actors interact and communicate within the scope of existing and potential Digital Library models, and the roles actors' play within the context of existing and anticipated services, several recurring themes emerged.

The first theme might be the most obvious: most digital libraries operate on models based on non-digital environments. As a result, the perceptions of actors and the roles they play are biased by traditional views, which might not be automatically transferable to the digital world, nor are they appropriate for some new emerging environments.

That leads to the second theme: new models are challenging traditional approaches and in many cases result in the redefinition of actor roles, as well as the introduction of new roles that previously did not exist, or were not performed by the same type of actor. Finally, due to the lack of means of formal expression, it is difficult to understand objectively the key actor/role issues that arise in isolated Digital Library cases, or to perform comparative analysis between different cases.

This directly affects the ways in which the Technical Problem Areas identified by the DELOS/NSF Network of Excellence brainstorming report of June 2001 [11] will be addressed. The report states that the "highest-level component of a Digital Library system is related to the system's usage." It goes on to state that by understanding that usage (i.e., by understanding actors, roles, and relationships), digital libraries will improve their ability to enable optimal User experiences, provide support to actors in their use of Digital Library services, and ultimately ensure that the information is delivered or accessed using the most effective means possible.

The process of developing a sophisticated classification of actors and roles can be done on the basis of empirical analysis of actors and their relationships in existing Digital Libraries, (as in [1] and [27]), or it can be developed from a more theoretical perspective (where our User-Agent-Professional model might be a simple example of a starting point). The use of these models has the potential to reveal patterns of interaction among Digital Library actors, in both practical and theoretical ways. New analysis of roles and interactions will lead to, amongst other things, precise definitions of requirements that may be applied broadly, to the development of generic techniques and technologies, as well as to the promotion of standardization of services, components, and interfaces (which, in turn, promotes re-usability and interoperability). The impact of this work affects all areas of digital libraries from generic and global authentication systems and models of authority control, to personalization and adaptive services and interfaces, and new models and tools for digital publishing.

On a small scale, the Relations Board and the sample scenarios demonstrate the powerful potential for analysis tools derived from even the simplest descriptive model. Scenario 2, for example, describes a situation in which significantly different service instantiations may have the same underlying conceptual model in terms of actors and their interactions. Therefore, there is a high probability that these services belong to the same global scenario.

Without sufficient means to formally express the attributes and behaviors of a network of actors related by specific services, there will continue to be a misunderstanding with regard to actors in terms of their requirements, designed solutions, and in the evaluation

of results. This is the most important conclusion that can be drawn from our working group experience.

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