

Towards digital materiality: Imbrication of Services and the re-configuration of agencies

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ABSTRACT

This paper rests on recent debates on digital materiality to advance and engineering proposal for building Web 2.0 systems as Imbrications of Services (IoS). The key concept points to designing digital assemblages of non-human actors (i.e. technologies) that function interdependently so as to facilitate collective human intentionality in the context of non-trivial virtual work. Through this lens, we examine a popular coordination artifact, namely the calendar, to showcase how it may be re-invented to exhibit a digital materiality that spans across Web 2.0 services such as Google Drive, YouTube, Flickr and Disqus. The results demonstrate the feasibility of building tightly intertwined systems that exploit the distribution of material agency across digital services and appropriate the benefits of virtualization (e.g., by alleviating the need to for managing local data stores).

ACM Classification Keywords

D.2.2 [Software Engineering]: Design Tools and Techniques - H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces - H.5.2 [Information Interfaces and Presentation]: User Interfaces

General Terms

Design, Human Factors, Languages.

Keywords

Digital Materiality; Imbrications; Digital Assemblages; Calendars.

1. INTRODUCTION

Calendaring stands for a specific facet of coordination work entailing activities that refer to mundane events [19] and take place either subsequently or in anticipation of such an event. The practice of calendaring is traditionally anchored around different genres of the calendar artifact (e.g., paper-based personal agendas or wall calendars), with the latter frequently becoming intertwined with supplementary artifacts such as the phone and sticky notes, thus coupling calendaring with other human activities such as communication and alerting. With the advent of electronic calendars, such as Groupware Calendar Systems (GCS) and

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Online Calendar Services (OCS), the artifact of the calendar but also the calendaring practice, have experienced substantial re-configurations [19,25,29]. Nonetheless, the key functional purpose of calendars, namely personal time management, has remained unchanged for most of the time. On the other hand, there are various scholarships indicating that personal time management is just a small subset of the most complex process of calendaring [4,14,23,24,26]. It is also claimed that due to this limited focus, the use of calendars in non-trivial work settings has been rather limited and restricted.

The present research is grounded on the belief that the digital medium holds the potential to re-organize the calendar artifacts as well as the calendaring practice so as to facilitate novel virtualities and complex collaborative engagements. The approach followed is inspired by sociomaterial perspectives on design [15,17,18,20,21] and seeks to re-orient the design of OCS so as to broaden their use and improve their digital materiality. In doing so we are also keen to engage constructively in debates that qualify and shape the sociomaterial perspective and the metaphor of imbrications into designing interactive collaborative systems.

The rest of the paper is structured as follows. The next section reviews the related theoretical ground, introduces Imbrication of Services as an alternative pathway and motivates the problem at hand. Then we elaborate on a “proof of concept” show case to present our current efforts on designing a re-constructed calendar with enhanced capabilities and conclude by discussing some of the implications.

2. BACKGROUND AND RELATED WORK

2.1 Calendaring Practices and OCS

Calendars coin an artefact that embodies representations of time-oriented schedules that anchor events in such a way so as to support a kind of synchronizing between people and activities [24]. Calendaring practices (i.e., Calendar-oriented work) comprise a wide range of activities which materialize as operations on objects through which people interact with these artifacts. Researchers have attempted to qualify calendaring in terms of functional purpose. For example, Payne [26] asserted that the primary purpose of calendars is to support ‘prospective’ remembering (i.e., remembering to do things) which is facilitated through articulating intentions and events that have not only certain properties (i.e., title, description, duration, priority, time constraints etc.) but also certain nested dependency structure. In a similar vein, Palen [23] acknowledged ‘retrospective’ remembering (i.e., recalling past events) as a significant aspect of calendaring and introduced six new types of activities entailed in

calendar (namely, temporal orientation, scheduling, tracking, reminding, archiving, retrieval & recall).

Subsequent studies [22,28,29] argue convincingly that electronic calendars succeed to support only parts of Palen's calendaring activities. Specifically, although OCS appear to be strong enough at facilitating temporal orientation (by supporting multiple views i.e., day, week, 4 days, month, agenda etc.) and reminding (by supporting custom notifications and alarms via email or SMS services), they are relatively weak at scheduling, tracking, archiving and retrieval. For instance, scheduling is partially supported by calendar sharing, automatic scheduling mechanisms among users that share their calendars with each other and event invitations via email to guests. However, users are not able to negotiate details of a future tentative event (prior to scheduling it), while once the event is scheduled, there is only the option of recurrent updates by users who have edit rights in the event's respective calendar. Furthermore, users with view rights in this calendar can only see the latest version of the event's details, missing out the preceding negotiation. From this perspective OCS perform poorly in tracking activities, as they fail to make an event's digital traces and history persistent, explicit and accountable. In a similar vein, archiving and retrieval are demanding calendaring activities that imply intelligible consolidation of event's outcomes. In today's OCS users can only add some notes (i.e., text) in scheduled events which by itself doesn't support sufficiently their need for mapping tentative, scheduled or completed events with various resources and multimedia artefacts (i.e., task lists, contacts lists, reports, documents, photos, videos, notes etc.).

From the above, two main conclusions stand out very promptly. On the one hand, it becomes evident that the digital medium has transformed the physical properties of the object of the calendar so that its digital counterpart is no longer conceived in terms of material properties such as paper type, size, weight, durability, containment, density, etc. Through this process, digital calendars invoke different material concerns in the sense that they enable or constrain new practical instantiations and significance. On the other hand, the transformation has not reached the point of re-inventing the calendaring practice. Indeed, it is still challenging to (a) codify the negotiations taking place prior to these events (b) articulate post-event activities (such as indexing contributions, intuitive consolidation, reuse of materials associated with a certain event, etc.) in a manner that is meaningful and appropriate for human partners; and (c) account for the rationale leading to these events but also their implications. At the core of these limitations lies the imperative that events can be created and updated, but not planned, negotiated or justified (prior to creation). Similarly, events can trigger notification and reminders, but not consolidation, indexing, reuse and post-reflection (after expire).

Due to this imperative, both the 'cultural' properties of calendars and the 'plasticity' of their digital manifestation are constrained and underserved. For instance, calendars are frequently classified by religious commitments (i.e., catholic versus orthodox Easter) and other cultural bindings (i.e., office hours etc.), that necessitate flexible anchoring of events around semantic demarcations. This form of plasticity is rare (if at all present). Similarly, although automatic notifications and alerts are generically provided, the capacity to intuitively augment events with other multimedia resources such as online discourse, photos and video, is lacking. As a result, it is hard to reveal and unfold micro-negotiations behind events; assess triggers of consensus or disputes; compile

individual and collective contributions, etc. Equally hard is to appropriate an event's retained online remains [11,12] for articulatory tasks such as indexing, consolidation and reuse.

2.2 Research focus

In order to alleviate some of these limitations, the present work revisits basic premises of calendaring with the intention to extend affordances inscribed to events. This is grounded on the normative perspective that events have pre- and post-creation life, which is both meaningful and useful for justifying why certain events exist in a certain context (pre-creation life) and what implications they bare for collaborators (post-creation life). In sequel, we advance a design proposal that extends the digital materiality of calendaring by making events capable of retaining digital traces across multiple digital services.

3. DIGITAL MATERIALITY

3.1 Perspectives

Although the scholarship on digital materiality lacks consolidation and specificity, there have been theoretical propositions that may drive design-oriented thinking. One thread of research concentrates on the changing view of software as being the material for novel virtualities [3], rather than just a tool, which has inspired various debates on digital materiality [7,8,16]. Another research stream [1,9,10,12,13] rests on the argument that computer-mediated social configurations (under certain conditions) exhibit a form of digital materiality which is determined by the technology's capacity to retain digital evidence of user interactions in a form that is suitable for further processing and analytical insight. Thus, specific genres of software appear to be, not only the material, which invokes social agency (either individual or collective), but also the medium through which material concerns are manifested, become tangible and sensible.

On the other hand, organizational theorists and management scholars [2,21] contribute to the issue of materiality by attempting to gain insights into the role of technology in distributed organizing. To this end, they challenge the conventional view of IT as black box in favor of novel concepts such as 'sociomaterial entanglements' [21] or 'imbrications' [17,18]. Entanglement coins the view that the 'social' and the 'material' are not distinct and independent spheres of organizational life, but actually entangled in organizational practices. Works by Orlikowski and colleagues [20,21] adopt this theoretical stance and advocate the metaphor of 'sociomaterial entanglement' as an approach for analyzing and understanding enacted organizational routines.

However, more recent works that explore sociomateriality as a lens for design the perspective of 'sociomaterial entanglement' is critically appraised and compared against the notion of 'imbrication' [6,15,17,27], a term that describes the arrangement of distinct elements in overlapping patterns so that they function interdependently. Leonardi, used the term imbrication to qualify the intertwining of human and material agencies into human routines and technologies [17]. More recently, he claims that 'imbrication' is more appropriate metaphor for design, arguing that 'entanglement' implies a commitment to treat the 'social' and the 'material' inseparably suggesting that the sociomaterial is one thing, not two [15]. Other researchers also recognize this limitation and conclude that the 'sociomaterial entanglement' perspective leaves no space for improvement [5]. Instead, the metaphor of imbrication offers more opportunities for design

intervention, as it assumes that sociomaterial assemblages can be disentangled, separately improved and re-arranged.

3.2 Imbrications of digital representations

Following this line of thinking, the conception of imbrication of digital representations in Information Systems rests on the formative claim that in virtual settings, material agency stems from the technologies' performative capacity as inscribed into whatever digital representations are embedded. Then, human agency invokes operations with, on, within or through digital representations [2]. Cloud services (e.g., YouTube, Flickr etc.) can be considered as distinct virtual settlements where various digital representations of human (e.g., profiles) and non-human (e.g., designated artefacts like videos, comments etc.) actors are imbricated in specific ways to facilitate goal-oriented activities such as video and photo sharing, networking patterns, communication, etc. Although, these representations are interconnected within a bounded system (i.e., YouTube) that performs as an integrated environment, it is obvious that a service can be (and it is regularly) dis-entangled (so as to improve specific properties) and then rearranged in a different way. Such a rearrangement may then lead to changes in established human routines.

Using this lens to conceive affordances of OCS, it is straight forward to anchor certain prominent imbrications of digital representations. For example, alerts and notifications are two examples of imbricating digital representations of users (e.g., when selecting who is to be notified) and artifacts (e.g., clock for setting time or map for designating a place for triggering alerts), all simultaneously embedded in OCS and/or email services. Moreover, the use of certain access credentials (i.e., Google, Facebook or Twitter accounts) to register virtual presence in another digital service is another example of imbricating digital representations of users. Finally, the capacity to attach entire calendars to web sites without any programmatic control is also conceived as imbrication of digital representations.

These sorts of imbrications, although useful and powerful, suffer from three limitations. The first is that they support a narrow form of interoperability which is reduced to instantiating or replicating designated referent objects (i.e., users) or functions (e.g., time- or location-based alerting) from one digital space in another. As such instantiation/replication is configured once (upon execution), it cannot accommodate subsequent changes of state in the referent object. The second limitation is that such imbrications are strictly inscribed in code through direct calls to functional segments that define the referent object. This in turn makes certain affordances possible, but not others that may be equally useful. Finally, this method of imbricating limits the capacity for digital trace data that span boundaries and virtual settlements. Thus, it is not possible to combine what users do in two separate digital spaces to make sense of their broader online activity.

Arguably, a more appropriate baseline for imbricating is through linking to (rather than directly calling) referent objects and functions. As briefly discussed below, this offers a broader view on imbrications which leads to benefits not viable through instantiation/replication of digital representations.

4. IMBRICATION OF SERVICES

Notwithstanding the level of bounded systems, imbrication may be used to anchor web 2.0 as a paradigm for computing.

Specifically, web 2.0 and the social semantic web can be conceived as imbrication of different bounded systems that adhere to certain protocols for interoperability to present a coherent whole or a common practice that assumes activities such as user profiling, user-generated content management, searching, expressing opinion, connecting with others, etc. The intrinsic ways in which these activities are facilitated in each different virtual setting (i.e., YouTube, Flickr, LinkedIn, ResearchGate, etc.) constitute the imbrication of digital representations at the micro-level (i.e., the specific bounded system). At the macro-level, these bounded systems and the tactics for interoperability (i.e., mash-ups, open APIs, sharing widgets, etc.) form the imbrication that qualifies web 2.0 as a computing paradigm of a digital sociomaterial assemblage.

The above lead to the conclusion that Imbrication of Services (rather than digital representations) can provide an appropriate engineering method for treating digital materiality as traceable evidence of human and non-human actors retained across bounded systems and services. Then, the capacity to retain and make available for further processing such digital traces anchors a kind of material agency to be embedded into web 2.0 applications and services.

To clarify the concept, let's assume two services (their scope is irrelevant), each being a 'bounded' system with designated material capacity that invokes certain human actions, while constraining others. Then, imbrication of any two services implicates provisions to accommodate three requirements / prerequisites. Firstly, representations embedded in each bounded service should be indexed by virtual referents in another (concrete or abstract) service. Secondly, in the host service virtual referents should be intertwined with whatever representations are embedded in that (host service). This implies a kind of imbrication of representations that rests on provisions for quality attributes such as abstraction, translucence, interoperability, etc. Thirdly, the mix of host representations, virtual referents and quality attributes should establish a new material agency that entails human intentionality. When such human intentionality is enacted, it results into a form of collective social agency whose digital materiality is traceable across boundaries. In this manner, new digital assemblages between human and non-human actors can be envisioned so that intentions previously constrained can now be invoked and embedded in a new collective agency.

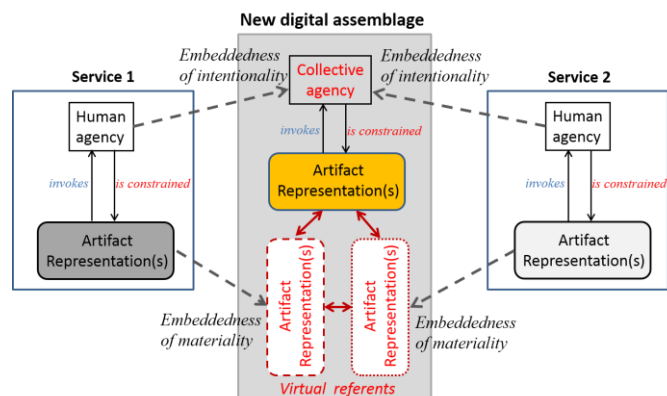


Figure 1: Scaffolding the notion of Imbrication of Services

Figure 1 consolidates the above into a scaffold that depicts the conception of Imbrication of Services as an alternative pathway for designing interactive systems. The difference from other

perspectives (e.g., imbrication of representations) is not only at the micro-level (i.e., how standalone services are extended and revised) but also at the macro-level where the prominent challenges include collectivity, plasticity and multiple boundary spanning. It is at this level that digital materiality manifests itself as digital traces retained across bounded systems and services and shapes the distinction from other forms suggested by alternative (perhaps valid and promising) solutions.

5. USE CASE AND IMPLEMENTATION

5.1 Use case and critical appraisal

Consider a hypothetical virtual alliance in organic farming consisting of farmers, agriculturists and certification experts. The farming association due to commercial deals undertakes to produce specific amounts of certain cultivations (e.g. tomatoes, potatoes etc.) this year. To this end, association's president decides to arrange a meeting with agriculturists and certification experts aiming to build a valid production plan. After several negotiation cycles between alliance's members a specific date and place is set and the president prepares meeting's agenda and allocates preparatory tasks to partners. From this point on and in the period leading to the meeting, certain contributions are expected regarding to the role of each partner. So, farmers must provide reports and lists about available farmlands, while agriculturists have to provide them information and guidelines for achieving the specified quantitative and qualitative goals. On the other hand, certification experts are responsible to inform agriculturists for certification's prerequisites and suggest an appropriate protocol to be followed. If everything goes thoroughly and after the completion of the meeting, the president compile meeting proceedings and all related resources to produce detailed reports for later use and consolidation.

The scenario points to a fairly typical coordination activity where multiple parties with different roles and competences become involved over a period of time in the preparation and proceedings of a meeting. The actual conduct of the work may also implicate several artefacts (e.g., calendars, task lists, presentations, charts, reports, documents, videos, photos, audios, digital archives, etc.) at different stages to suit specific purposes. As for the venues available to organize the activity, there are a variety of technology genres that may be deemed appropriate. For example, one may envision use of:

- (a) an OCS for finding a convenient date (i.e., a date that everyone is available/not busy), scheduling and sharing the event, as well as inviting guests and asking them to declare intention to participate or not;
- (b) communication media such as telephone, e-mail or face to face dialog for negotiation
- (c) task management service or e-mail for producing shareable task lists and
- (d) online file sharing services to store digital event-related materials (e.g., shared documents, presentations, videos, photos, audios etc.).

Whatever the mix of technologies, it is worth noticing that the capability of organizing and handling pre- and post-event details rests entirely with the human actors rather than the technologies at hand. This is due to lack of explicit inscriptions (in the technologies) for aligning the actual event of the meeting with the information (i.e., social exchanges, commitments and contributions) that surrounds it, prior to and/or after setting the

specific date. Thus, it is up to the actors to invoke routines that bypass constraints imposed by technology.

Revisiting our scenario from the perspective of imbricating services, offers a useful roadmap not only for identifying the human routines improvised to by-pass technological constraints but most importantly, for envisioning a re-allocation of agencies that broadens the possibilities for action, thus creating new human capabilities.

5.2 Implementation

Attempting to assess the concept's validity, we have embarked in an effort to re-engineer an online calendaring service so as to alleviate some of the shortcomings of established calendaring practices. The assumption is that in the course of planning, negotiating and conducting coordination activities (such as meeting arrangement but also other sorts of collaborative virtual work), the parties involved stand to benefit from the imbrication of services with different material agencies. For the purposes of this study, the focus is on imbricating services such as Google Drive, Flickr, YouTube, Google Tasks and Disqus with the Google Calendar. Such imbrications will allow digital resources retained by these services to be linked to the events in the calendar so that they form a digital assemblage of human and material agencies acting interdependently. Given this intention, the design objective is to re-invent a calendaring practice that provides more adequate support for activities currently underserved by popular OCS (i.e., scheduling, tracking, archiving and recall and retrieval).

An existing calendaring service namely Google' Calendar was chosen mainly due to the maturity of its public API (currently in version 3.0). Then event management in Google Calendar was to be re-engineered so as to imbricate services such as Disqus (to appropriate capability for online discourse, negotiation and argumentation), Google Tasks (to appropriate task management facilities), as well as Flickr (for photo-sharing), YouTube (for video sharing) and Google Drive (for file sharing).

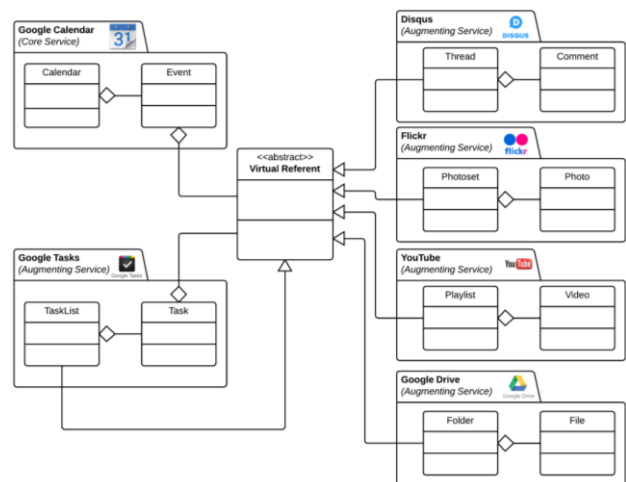


Figure 2: IoS in the re-constructed calendar

The class diagram in Figure 2 outlines the pattern for IoS. This pattern is grounded on the fact each service, irrespective of functional purpose, is built around a main data type type (i.e., Event, Task, Comment, Photo, Video and File) and a collection that aggregates objects of that data type (i.e., Calendar, TaskList, Thread, Photoset, Playlist and Folder). Thus, according to Figure

2, events and tasks can aggregate multiple instances of the class “virtual referent”, which stands for an abstract super class that represents instances of collections resident in target services.

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▼ extendedProperties {1}
  ▼ private {13}
    taskManagement : {\ "taskListOutcomesFolder\":"0BzSV8cg9OcOcaJltWU8zQk2hY1U\","taskListNegotiation\":"2180568006\","taskListId\":"MTc5NTQzMzg2NDg5ODg2NjYyNjc6MTQ5MzU0MzY4Njow\" }
    outcomesManagement : [{"flickr_photosetId\":"72157644038079935\","youtube_playlistId\":"PLuNVuHuyqEbUSxI4T3uMB7N02Yw9Smu_n\","googleDrive_folderId\":"0BzSV8cg9OcOCTDA2UTE2NTFNauk\"}]
    eventNegotiation : 2180545710
  
```

Figure 3: Linking Google Calendar events to their digital traces hosted in other services

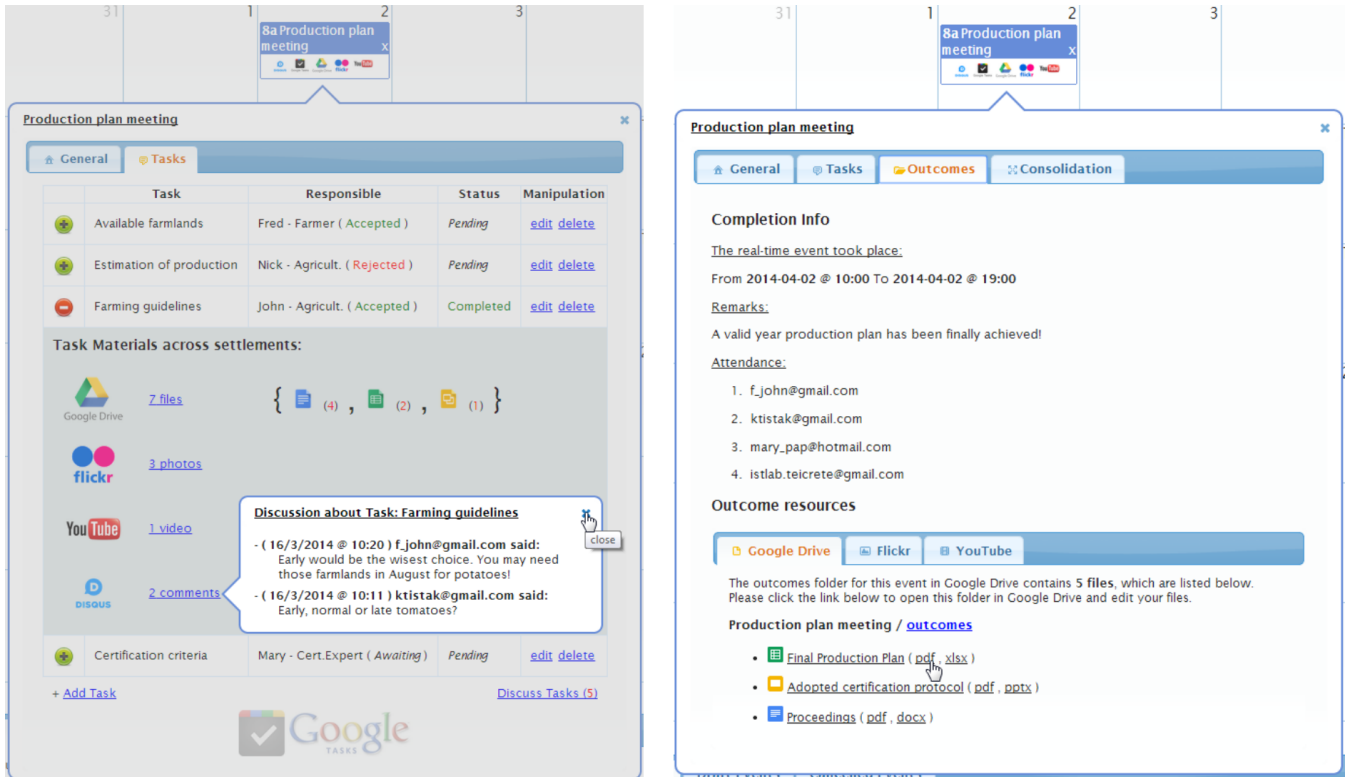


Figure 4: Allocating the preparatory work before the meeting (left); Archiving digital resources after the meeting (right)

As shown, a completed event hosted in Google Calendar links to (a) one list of tasks for its preparatory work hosted in Google Tasks; b) two or more threads of comments hosted in Disqus; c) one folder with two sub-folders of files hosted in Google Drive; d) at least one list of videos hosted in YouTube; e) at least one set of photos hosted in Flickr. Clearly, such a revised representation of the event (featuring imbrication of multiple online services) entails improved affordances that stem from the capacity to manage event-related digital traces distributed across different virtual settlements. As an illustration of the new capabilities, Figure 4 depicts the state of affairs in our reference scenario, where the farming association’s president co-engages with his partners to allocate the preparatory work into tasks (Figure 4-left) and then to consolidate event-related digital resources (Figure 4-right). In both cases, it is worth noticing the use of labels in the Calendar’s event designating the imbricated services.

6. DISCUSSION AND CONCLUSION

The present work is a step in the direction of articulating the metaphor of imbrications for designing interactive systems. Such

Figure 3 depicts an illustrative example of using Google Calendar API to allow calendar events to appropriate digital traces distributed across and retained in different digital services.

a commitment brings about theoretical and engineering concerns that shift the focus of designing interactive software from the conventional tool- or system-perspectives towards a sociomaterial orientation. The result points to tightly intertwined systems that exploit the distribution of material agency across digital services and appropriate the benefits of virtualization (e.g., by alleviating the need to for managing local data stores).

At the engineering level, our research proposes a method for imbricating services (see Figure 1) which is intended to provide an implementation agnostic guide. To this effect, we have refrained from detailing intrinsic facets of an implementation strategy (i.e., reliance on certain API features, use of web standards, etc.) as this is not of primary concern to the present work. Nevertheless, the method assumes certain pre-requisites (pointing to basic conditions for candidate services to be imbricated) and prescribes certain outcomes. The pre-requisites include provisions for: (a) common web 2.0 premises [12] such as user profiling, tools for expressing opinion and communicating, finding and searching for information and establishing connections and (b) appropriate and mature public APIs. Both

these are subject to further details which are not elaborated in the present work.

As for outcomes, IoS entails several primary benefits. Firstly, it paves way for systems that constitute meta-configurations of other systems. Indeed our calendar is totally relieved from the need to manage local data stores, as storage capacities are distributed and retained by each separate service. Secondly, systems imbricating other services, feature collective social agency which is entangled with multiple (previously separate) material agencies of bounded systems and / or services. The showcase presented in this paper indicates that the new calendar would be most useful when multiple parties co-engage in a coordinated manner to accomplish goals through virtual work that spans boundaries. In such cases, there is a compelling need for a technical re-configuration that invokes new possibilities for action as the calendaring experience is enhanced to support activities where conventional GCS and OCS fail to accommodate. Finally and as a by-product of entangling cross-settlement resources, it is made possible for users to understand why certain events exist, how they were brought about and what implications they raise.

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