

Sociomaterial Configurations of Human and Non-Human Actors: Re-Inventing Family Trip Planning Through Imbrication of Services

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Abstract—The present work explores theoretical threads which may be used to inform the design of interactive systems that exhibit digital materiality. The research is motivated by current thinking on sociomateriality and distributed organizing as populated in different scholarships. From the range of conceptual foundations, the paper picks on the concept of imbrication and advances a conceptual scaffold for imbricating services. A design showcase is used to briefly illustrate how imbrications of services combined with digital ‘tells’ and online remains can improve upon the digital materiality of certain family practices such as vacation planning.

Keywords—Virtual work; Affordance-based design; Imbrications; Calendaring practices

I. INTRODUCTION

Debates on design-oriented thinking in the field of HCI have been on-going for at least three decades. In this endeavor, various propositions have been made drawing upon cognitive theories, social perspectives and engineering frameworks [1] [11] [17] [36] [35]. Although there have been success stories, these are not easily generalizable across technological regimes, thus making compelling the search for new insight and improvements. In this vein recent scholarship sets the focus on sociomateriality and explores its implications for design [27]. The present research aims to contribute to this debate by focusing on digital materiality [7][8][9][12][24] and its relevance to HCI engineering practice. The work builds on two threads of research; on the one hand, it reflects upon the baselines of sociomaterial perspectives as populated in organizational science and information systems research [25][28][29] and on the other hand, it explores the promises of the metaphor of imbrication [26][27][19] for designing interactive systems. The rationale rests on the premise that despite wide acknowledgements of the new primary beneficiaries established by new technologies [14][23], it is not yet clear exactly what may be the material features embodied in these technologies and how these implicate novel practices. Attempting to remedy for this limitation and by elaborating on different theoretical literatures, such digital materiality [8][12] and imbrications [26][19], the paper seeks to advance an analytical perspective for understanding the role of digital artifacts and the quality attributes that determine their appropriation and enactment in today’s ubiquitous

settings. The contributions made are not so much in the theoretical treatment of the concepts involved, as in some of the design-oriented concerns implicated when HCI researchers seek to understand the digital setting as a new space of opportunities and communicative exchanges.

The rest of the paper is structured as follows. The next section motivates the present work by establishing links with relevant scholarships. Then, we elaborate on the concept of imbrication and propose an engineering scaffold for building systems with traceable digital materiality. Following this, the scaffold is recruited in a ‘proof of concept’ showcase aiming to re-invent calendaring practice for family trip planning. The paper is concluded with discussion and pointers to future work.

II. THEORETICAL MOTIVATION

While the present research is inspired by the evolving traditions in HCI, it rests on a variety of scholarships that drive sociomaterial analysis, including distributed organizing [28][29], affordances [13][40][26] and digital assemblages [22]. In what follows, we attempt a brief elaboration of key terms to motivate our current research goals.

A. Sociomaterial perspective(s)

In organizational studies and management science, sociomaterial analysis coins a research strand aiming to provide insights into how technologies (i.e., material constructions) and human actors (i.e., social agents) reshape organizational realities [28][6][25]. Sociomateriality is also addressed by information systems researchers by concentrating on the study of digital artifacts and their transformative capacity as they become embedded into human routines [7][26]. The common ground across these scholarships is that they challenge the conventional view of IT as black box in favor of novel concepts such as ‘sociomaterial entanglements’ [28] or ‘imbrications’ [26][25]. 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 [28][29] adopt this theoretical stance for analyzing and understanding enacted organizational routines. In more recent works that explore sociomateriality as a lens for design [27][9], the ‘sociomaterial entanglement’

perspective is critically appraised and compared against the notion of imbrication [10] [37][26][27].

Imbrication was first coined by scholars such as Ciborra [10] and Taylor [37], although in different contexts. Ciborra [10] aimed at theorizing the patterns of risk and use of digital technologies. Taylor [37] conceived organizations as imbrication of domains of discourse. In both cases, the term is used to describe the arrangement of distinct elements in overlapping patterns so that they function interdependently. Building on these conceptions, Leonardi [26] recalled the term to qualify the intertwining of human and material agencies into human routines and technologies. In a recent essay by Leonardi & Rodriguez-Lluesma [27], it is claimed that 'imbrication' is more appropriate metaphor for design, arguing that 'entanglement' implies a commitment to treat the 'social' and the 'material' inseparably i.e., the sociomaterial is one thing, not two [27]. Other researchers also recognize this limitation and conclude that the 'sociomaterial entanglement' perspective leaves no space to act for improvement [9]. Instead, the metaphor of imbrication offers more opportunities for design intervention, as it assumes that components of a sociomaterial assemblage can be disentangled, separately improved and then re-arranged. Debates such as the above have recently sparked various attempts to exploit sociomateriality as a lens for studying novel digital technologies such as game engines [32], plagiarism detection systems [19] and music notation lessons [3].

In the context of HCI, sociomateriality sets the focus on the design of interactive artifacts and their linguistic capacity within and across digital spaces or systems. This binds HCI design not only to devising digital manifestations of objects of work, but also to unfolding and treating the material qualities of these artifacts which enable or constrain their appropriation in different situated activities, including virtual work. This perspective, amongst other things, drives recent theorizing about the traceable digital materiality of artifacts as well as the way in which such traces can be used to ascribe (new) material agency to certain technologies.

B. Digital materiality

Although material concerns of computer-mediated settings are not immediately obvious [24], they have recently received attention due to the changing view of software as material rather than just a tool [7]. This has inspired various streams of research and debates on managing digital trace data [18] and the use of media as material [12]. Early works on 'digital' tells [21] advanced the concept of a cyber-archaeology of digital settlements thereby anchoring the materiality of virtual communities in online settings. Subsequent research examined specific digital settings, such as Second Life [16], the micro-blogging platform Twitter [15], video-sharing services [4] and social networking [2] to reach similar conclusions. Jacovi et al. [20] made a further step in qualifying enacted relationships in Social Networking Services by kind (e.g., interest versus following). The core theme underlying all these efforts is that computer-mediated social configurations (under certain conditions) exhibit a form of digital materiality determined by the technology's capacity to retain digital evidence of users' 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 invoking social agency (either individual or collective) but also the medium through which materiality is manifested as tangible and sensible.

C. Research focus

The present research is a step beyond earlier works in the sense that it attempts to systematize the design of interactive systems that exhibit traceable digital materiality. Phrased differently, our focus is not so much on the intrinsic properties of specific systems as it is on their performative capacity (i.e., material agency) and the traces left behind as different material agencies become interrelated to operate as a coherent whole.

III. IMBRICATIONS AND DESIGN SCAFFOLDING

In search for an appropriate metaphor to ground the concept of digital materiality, the notion of 'imbrication' is recruited as an analytical construct. Nevertheless, a distinction is made between imbrication of services versus imbrication of representations, claiming that the former offers a more appropriate baseline for design-oriented thinking.

A. Imbricating digital representations

This conception of imbrication rests on the formative claim that digital technologies constitute a bundle of inscribed representations that stand or substitute for specific types of social actors (i.e., users) or processes (i.e., compiling, sharing, encoding, etc.). Humans qualify these representations by different names to anchor the type of agency involved. For instance, user models or profiles are digital representations standing for certain type of user. On the other hand, a compiler pinpoints the process of transforming source code to executable object code. As these representations have their own performative capacity (i.e., material agency that designates the execution of processes such as profile management or compilation without human intervention), human agency invokes operations with, on, within or through digital representations [6]. Using this as lens, it is argued that Web 2.0 services (e.g., YouTube, Flickr etc.) can be considered as distinct virtual settlements where digital representations of human (i.e., individuals and virtual groups) and non-human (i.e., designated artifacts and processes) actors are imbricated in specific ways to facilitate goal-oriented activities such as video and photo sharing, networking patterns, communication, etc. For instance, YouTube is something more than an enormous video database. It is a digital assemblage where designated artifacts such as videos afford uploading, retrieval, sharing and commenting by virtual users who operate either with their digital representations (i.e., profiles) or on the representation of digital artifacts (i.e., videos, comments and video responses). Routine and recurrent work may lead to cyber-formations (thus collective agency) through subscription services that allow users to connect and co-engage using video collections (i.e., YouTube channels). Although, these representations are interconnected within a bounded system (i.e., YouTube) that performs as an integrated environment, it is obvious that YouTube 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.

B. Imbrication of Services (IoS)

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. As an example of this sort of imbrication (at the level of services), one may consider social web sites for newspapers or magazines such as Time (<http://www.time.com/>). They all utilize existing commenting services (i.e., Livefyre, Disqus etc.) so as to appropriate material agency that allows users to comment on articles. Noticeably, such an increasingly evidenced tactic is preferred from the option of developing own commenting mechanism. Likewise, Google enhanced the Google Calendar's digital materiality by choosing to integrate Gmail with the Calendar invitations, notifications and alerts services.

The above lead to the conclusion that imbrication of services can provide an appropriate engineering method for understanding more complex virtual work such as multi-party collaboration that spans boundaries of different virtual settlements (or bounded systems). In effect, such a method fosters the design of systems that imbricate multiple human and material agencies all bound by the digital medium i.e. web 2.0 rather than a specific system or service. This amongst other things allows the treatment of digital materiality as traceable evidence of human and non-human actors retained across

bounded systems and services. Then, the capacity to retrieve 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.

C. Scaffolding

Engineering interactive computer systems using the lens of 'imbricating services' rests on the view of 'software as material' and prompts designers to envision novel digital materialities established by digital traces retained across bounded systems and services. To clarify the concept, let's assume two services, each being a 'bounded' system with designated material capacity that invokes certain human actions, while constraining others. The functional scope of each service is irrelevant for the present analysis. Indeed, our analysis could apply to many popular social web sites or social networking services (in the sense of Kim et al. [23]). 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 consolidates the above into a scaffold that depicts the conception of imbrication of services as an alternative pathway for designing interactive systems.

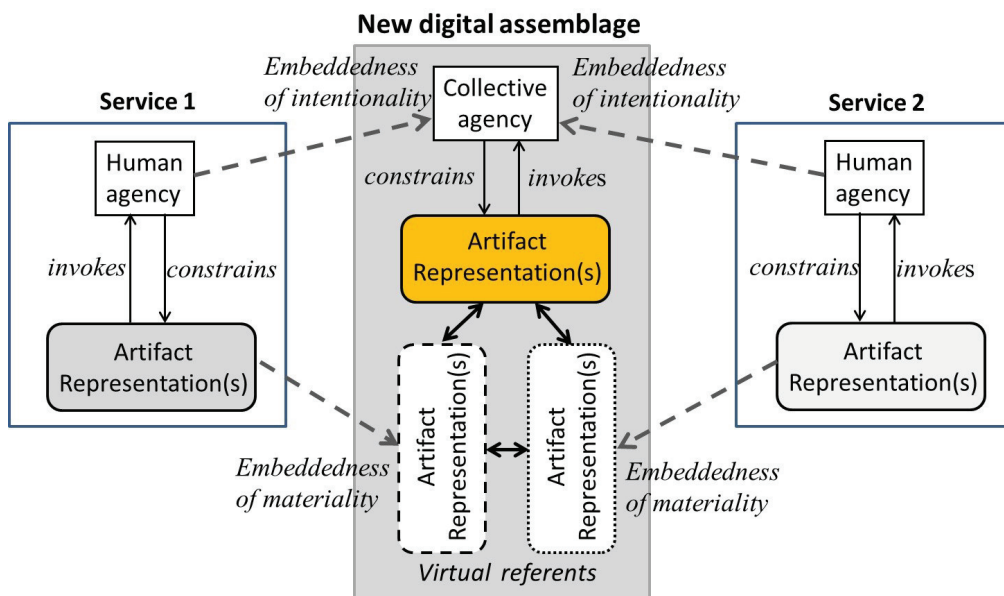


Fig.1. Scaffolding the notion of 'Imbrication of Services

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/or services and shapes the distinction from other forms suggested by alternative (perhaps valid and promising) solutions.

IV. CASE STUDY: TOWARDS A NEW CALENDARING PRACTICE

This section illustrates the concepts addressed thus far in an exemplar case, namely the use of online calendaring for family trip planning. Calendars coin an artifact that embodies representations of time-oriented schedules. They serve to anchor events in such a way so as to support a kind of synchronizing between people and activities [32]. 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 [30]. Payne [34] 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 [30] coined 'retrospective' remembering (i.e., recalling past events) as a significant aspect of calendaring and introduced six types of activities entailed in calendar work, namely Temporal Orientation, Scheduling, Tracking, Reminding, Note Recording / Archiving and Retrieval & Recall.

Subsequent studies [38] [31] [39] argue convincingly that electronic calendars succeed to support only parts of Palen's calendaring activities. Indeed, current online calendar services (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), but relatively weak at Scheduling, Tracking, Archiving and Retrieval. Specifically, 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.).

Consequently, it becomes evident that the digital materiality surrounding calendars may be substantially improved by making explicit, thus traceable and accountable, pre-event negotiations and social contracts as well as post-event (follow-up) activities. Pre-event data can highlight circumstances that lead to the scheduling of an event, and by this account, they may unfold the event's historical traces and social context. Post-event data may allow intelligible consolidation of contributions, indexing and reuse, thus a new kind of collectivity that combines and appropriates digital materials triggered by, solicited or otherwise made in the course of the event. Consequently, the primary objective of the present research is to explore the possibilities that lead to a new digital materiality of calendaring practices by inscribing into technology provisions for pre- and post-event management. Through such provisions, it is claimed that not only the artifact's material agency (i.e., range of functions performed by technology) is expanded, but also the enacted social agency is augmented, thus creating a new space for human actions.

A. Reference scenario & critical appraisal

Consider a hypothetical family who decide to plan a family trip with their friends. The husband may ask his wife's to check everybody's schedule and suggest a convenient date. After several negation cycles between the husband, his wife and the children, a specific date is set and the wife undertakes to invite friend families to declare their availability and propose tentative destinations. Ultimately and based on friends' responses, the family decides whether the trip is to take place on the specified date or be rescheduled. Once the final date and trip destination is set, husband and wife decide the preparatory work and allocate tasks to family members and friends. One of them notifies other participants and draws their attention to expected contributions (e.g., list of supplies from the supermarket, tentative rooms to rent etc.). In the period leading to the scheduled trip, negotiations between family members and their friends continue to take place leading to acceptance or refusal of responsibility for a particular task, proposition of another for a certain task or even change of trip's destination. After the trip, the family may decide to share trip-related resources (i.e., photos, videos, documents etc.) with friends or reflect back on these resources to recollect memories and experiences.

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 family trip. The actual conduct of the work may also implicate several artifacts (e.g., calendars, task lists, spread sheets, charts, notes, 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 family trip 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 involved to invoke certain routines to bypass the constraints imposed by technology.

B. 'Re-constructing' the calendar through imbrications

Using the lens of imbrications, our scenario may be revisited to identify the human routines improvised to by-pass technological constraints but most importantly, to envision a re-allocation of agencies that broadens the possibilities for human action. As an illustration of the concept's validity, we have re-engineered an online calendaring service in search of solution that alleviate (some of the) shortcomings of established calendaring practices. The baseline is that in the course of planning, negotiating and conducting coordination activities with the calendar, the parties involved stand to benefit from appropriating the imbrication of services with different material agencies such as Google Drive, Flickr, YouTube, Google Tasks and Disqus. Such a benefit stems from the capability to link events in the calendar with digital resources retained across these services. Thus, 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 & retrieval).

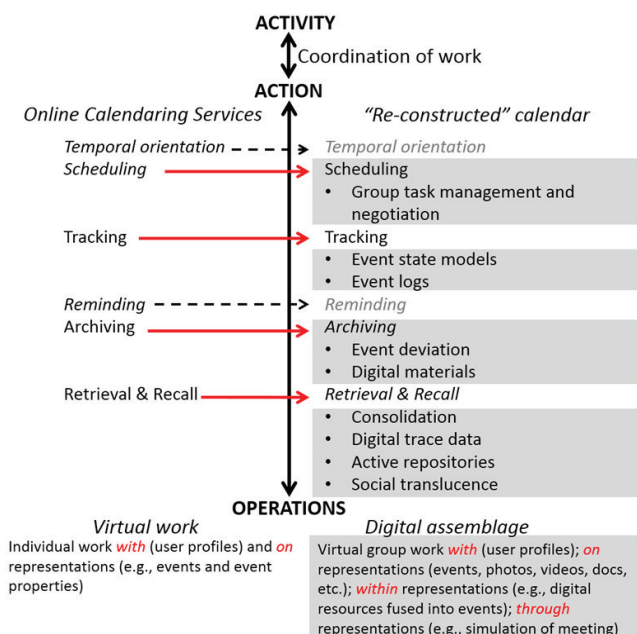


Fig.2. Current OCS vs. the re-engineered artifact

Figure 2 summarizes the design strategy and the expected outcomes. As shown, coordination work with the calendar is anchored as an 'Activity – Action – Operations' system. Thus, designated human intentions that constitute the calendaring practice (i.e., temporal orientation, scheduling, tracking, reminding, archiving and retrieval & recall) are contrasted across the individual (left part of the figure) and the distributed group (right part of the figure) settings to highlight changes in human routines. Thus for instance, maintaining task lists that comprise the primary scheduling instrument in the individual setting is re-arranged so as to serve group task management and negotiation in the distributed group setting. Similarly, tracking of start and end points of events in the individual setting is re-organized around event states and event logs. In this manner, events can be decomposed to a number of states such as drafted, scheduled, completed, etc., so as to depict a more dynamic state of affairs. Finally, archiving and retrieval & recall are re-configured so as to take advantage of the new capabilities offered by the imbricated services. Such new capabilities relate not only to the type of digital resources that can now be linked to events (i.e., discussion threads, photo sets, video channels, etc.), but also to new affordances for tracing, re-collecting and consolidate these digital resources on the fly.

In light of the above, the design work undertaken evolved in two stages. Firstly, the calendar's event model was revised to introduce additional states for events. Thus, an event may span four distinct states (i.e., prescheduled, draft, scheduled and completed) while in each state different possibilities for action are supported through mechanisms for tracking state changes and handling of digital trace data. Secondly, event states were configured so as to inscribe provision allowing peers to plan (through Google Tasks), negotiate (through Disqus), share resources (through Flickr, YouTube, Google Drive) and consolidate outcomes (through intelligible summative reviews of digital traces across spaces). The basic architectural pattern to achieve the above is depicted in Figure 3. As shown, the core constituent is the 'Virtual Referent' abstraction which undertakes to link events and tasks with whatever digital traces are retained in the target services.

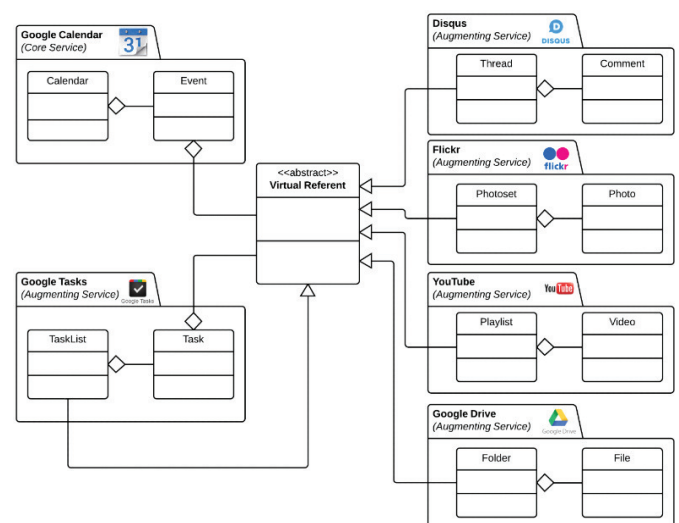


Fig.3. System's architecture

By this account, an event's digital constitution may invoke (a) allocation of tasks as long as the event is in the 'scheduled' state; (b) assignment of digital resources (i.e., documents, videos, photos, audio files, etc.) which can be linked either to specific tasks (during the event's 'scheduled' state) or to the event itself once it enters the 'completed' state; (c) negotiation support throughout the event's entire lifecycle i.e., not only the event's core properties but also the allocation of preparatory work and the event's tasks outcomes; and (d) creation of auto-generated reports consolidating the entire activity during each of the four states or the entire event's lifecycle.

As an example, Figure 4 depicts the state of affairs for an event in the 'draft' state. The draft state subsumes the 'pre-scheduled' state. In the 'pre-scheduled' state the event's negotiation entails interaction between specific roles such as the husband and his family members. In the 'draft' state the event is presented to the wider community (peer group / friends) for further negotiation and elaboration. So, in the 'scheduled' state, the event is depicted inside the calendar as the group has agreed to go for the trip between specified dates (Figure 5). In this state the wife clicks "more details" and proceeds to define a tentative work allocation. For each 'scheduled' event a respective task list is automatically created in Google Tasks. Additionally, a thread is created in Disqus to host comments at the Task List level. Likewise, for each task in the Task List, provisions are made for retaining digital traces in Google Drive, Flickr, YouTube and Disqus.

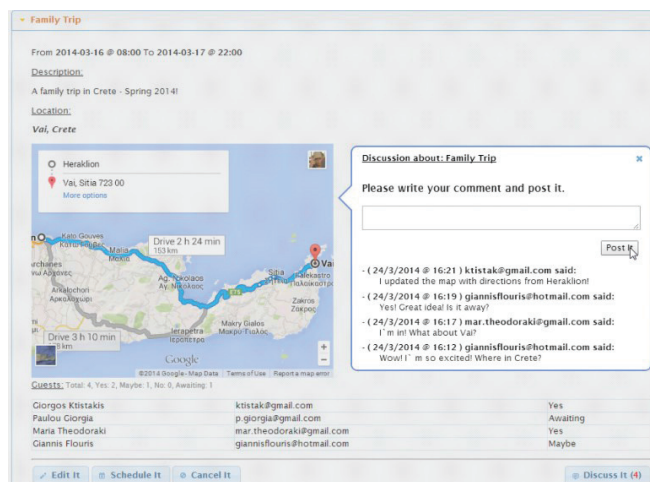


Fig.4. Negotiating event's details in draft state

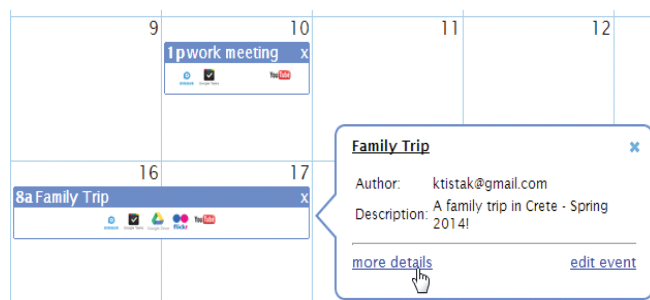


Fig.5. Containers depicting scheduled events and the services that host event-related materials

As the scheduled event's digital resources are populated, these are automatically assembled to provide evidence of the event's digital materiality (Figure 6-left). Notifications may be also used to prompt users to specific artifacts or issues pending attention. Once the event is anchored as 'completed', the balloon type dialog is enhanced to depict two additional tabs as illustrated in Figure 6-right. The 'Memories' tab invokes users to deposit information about any deviations from the planned event targets and data that could stand for digital memories of that event (i.e., photos, videos etc.), while the 'Consolidation' tab assembles the event's entire activity and compiles detailed reports indexing the digital materials across multiple settlements during one or all event's lifecycle states. For instance, Figure 6-right illustrates the event's photo gallery hosted in Flickr.

V. DISCUSSION, IMPLICATIONS AND CONCLUSIONS

The present work is a step in the direction of articulating the metaphor of imbrications for designing interactive systems. The rationale for imbricating i.e., arranging different materials in such a way so as to operate interdependently, in the area of information systems has been argued convincingly by various researchers and organization science scholars [10][37][27]. Although these works succeed in setting the conceptual lens, they do not offer the guidance needed by designers to plan and carry out design activities leading to systems qualifying as imbrication of distinct digital components. Phrased differently, the essence of imbrication namely an emergent configurability of interdependent material agencies, each with own and separate performative capacity and human intentionality [41] is still loosely served. This is especially the case in the field of HCI where the material turn in design has only recently been argued for.

Our current effort can be seen as an attempt to provide a step towards filling this gap. This has been approached by advancing an implementation agnostic scaffold which was subsequently used in a concrete case of coordinative work with the calendar to illustrate a reconfiguration of the calendaring practice through sociomaterial entanglements of human and non-human actors (i.e., material agencies of designated web 2.0 services). The underlying concept is the calendar can be re-configured by treating Web 2.0 services as materials that are glued together to act interdependently to service designated human intentionality.

A. Contributions

Attempting to anchor the contributions of the present research to the field of human centered systems development, it is important to briefly comment on the issue of devising the scope of imbrications. It can be argued that imbrications may be scoped either at the level of digital representations or bounded systems and services. In the former case, the units being imbricated need not possess material agency. For instance a piece of code is a digital representation which by itself embodies no performativity until the compiler transforms the code in such ways that it can be operated by human beings. The latter case however, entails imbricating services that possess their own pre-existent material agency. Therefore, the challenge amounts to configuring these separate material agencies so as to operate interdependently.

Such imbrications are improvised on the basis of constraints imposed by currently available technologies (rather than repress). Such constraints drive the need for revising, extending or re-configuring technologies so as to serve novel human intentionality. In the case of the calendar, this is illustrated in Figure 7 which depicts schematically the interplay between human routines and prevalent technological arrangements. Constraints, such as lack of unified virtual identifiers for digital artifacts, lack of appropriate (semantic) APIs as well as low-level inscriptions in designated

technologies, limit their interoperability and constrain their plasticity. Imbrications of Services constitute a pathway that is tuned to alleviating these constraints by re-configuring the calendar to exhibit a material agency that allows events to be anchored by state and maintain digital traces across virtual settlements. Such new material agency can then invoke novel human intentions as the calendar is transformed from a coordination artifact for scheduling events to an emergent activity-oriented digital repository of distributed data sets.

Family Trip

General Tasks

Task	Responsible	Status	Manipulation
Places to sleep (hostels etc.)	Flouris G. (Accepted)	Pending	edit delete
Snorkeling equipment	Flouris Harris (Rejected)	Pending	edit delete
Places to visit (beaches, museums etc.)	Theodoraki M. (Accepted)	Completed	edit delete

Task Materials across settlements:

- Google Drive: 7 files { (4), (2), (1) }
- flickr: 2 photos
- YouTube: 1 video
- DISQUS: 5 comments

Supermarket supplies: Ktistakis G. (Accepted) Pending [edit](#) [delete](#)

[+ Add Task](#) [Discuss Tasks \(3\)](#)

Google TASKS

a) Scheduled event - allocating preparatory work

Family Trip

General Tasks Memories Consolidation

States Lifecycle

Transition moments	Prescheduled	Draft	Scheduled	Completed
Core Updates	(3) Updates by (2) Editors	(6) Updates by (2) Editors	(1) Update by (1) Editor	(3) Updates by (2) Editors
Persons Involved	(2) Editors	(2) Editors and (5) Guests	(1) Editor, (7) Guests and (4) Task Responsibles	(2) Editors, (6) Attendants and (1) Observer
Activity across settlements	(6) Comments by (2) Editors	(3) Comments by (1) Editor and (1) Guest	(7) Comments by (2) Editors, (1) Task Responsible and (2) Guests	(5) Comments by (1) Editor, (2) Attendants and (1) Observer
DISQUS	(6) Comments by (2) Editors	(3) Comments by (1) Editor and (1) Guest	(7) Comments by (2) Editors, (1) Task Responsible and (2) Guests	(5) Comments by (1) Editor, (2) Attendants and (1) Observer
Google Tasks	No Activity	No Activity	(5) Tasks assigned to (3) Task Responsibles by (2) Editors	No Activity
Google Drive	No Activity	No Activity	(3) Files of (2) types attached by (2) Task Responsibles	(6) Files of (3) types attached by (2) Editors and (1) Attendant
flickr	No Activity	No Activity	(5) Photos attached by (1) Editor, (2) Task Responsibles	(3) Photos attached by (1) Editor and (1) Attendant
YouTube	No Activity	No Activity	(6) Videos attached by (2) Task Responsibles	(2) Videos attached by (1) Editor

You have selected: Activity in Flickr during Completed state

Brief Summary:
(3) Photos attached by (1) Editor and (1) Attendant

Detailed Activity:
Flickr: Family Trip / memories

vai 3
uploaded by ktist@k

1 / 3

flickr

(a) Completed event - archiving digital memories and consolidating

Fig.6. Instances of the calendar event in 'scheduled' and 'completed' states

This is evidenced from the case discussed earlier which illustrates that in the absence of unified virtual ids and semantic APIs, imbrication of services enables a range of previously separate functionalities (i.e., file-, photo- and video-sharing, task management and online discourse) supported by different digital services, to act interdependently as components of a new digital artifact – the new calendaring service. Such a service inherits the information processing capacity of online calendaring systems, but more importantly, it accommodates novel functionalities for pre- and post-event management which service intentions such as archiving, workflow management and digital trace data monitoring. It is precisely this re-configuration which transforms the calendar from a time-oriented scheduling artifact into an activity-oriented digital repository where information is anchored to events that have multiple states and improved capacities for archiving digital resources distributed across services.

B. Implications

The present research brings about theoretical and engineering implications for designers of human centered systems and services. As briefly discussed below, these implications often exceed the strict boundaries of the HCI discipline as they pinpoint issues of more general nature. At theoretical level, it is argued that imbrication of services is aligned with conceptions of digital artifacts as malleable, modularly constructed, editable and reprogrammable objects of practice. This entails a shift in the focus of designing interactive software from conventional tool- or system-perspectives towards a material orientation that brings to the forefront the affordances of the imbricated digital materials. In our example, this is evidenced from the fact that the new calendar rests on the purposeful configuration of services, such as Flickr, YouTube, Google Drive, Disqus (each with its own performative capacity and human intentionality), which are arranged in such a way so as to operate interdependently. Then, the reconfiguration of the embedded material agencies can invoke collective intentionalities signifying the emergence of digital assemblages that span system boundaries.

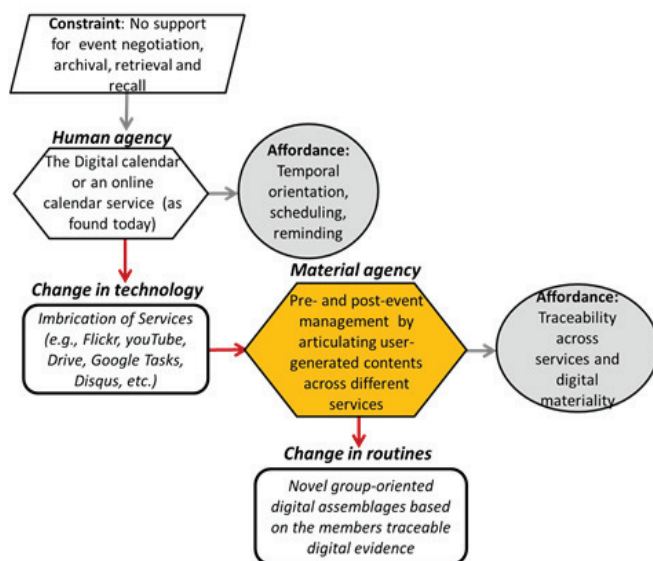


Fig.7. Imbrications vs. agencies

It is worth noticing that in attaining this goal it is not only the artifact's interactive manifestation that is transformed (through changes in the form of the embedded representations), but also the corresponding practice as subsumed by the flow of routines through which peers become co-engaged. Consequently, online calendaring is re-aligned so as to facilitate archiving, recollection and intelligible consolidation of digital traces spread across the imbricated services, in addition to event scheduling and notifications.

At the engineering level, our research implicates a method for imbricating services (see Figure 1). The primary scope of the method is to provide an implementation agnostic guide for arranging bounded digital services so as to operate interdependently. 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 common web 2.0 premises (such as user profiling, tools for expressing opinion and communicating, finding and searching for information and establishing connections) and appropriate public APIs establishing rules and specifications that software programs can follow to communicate or 'interface' with each other.

As for outcomes, imbrication of services appears to be appropriate when collective social agency is to be entangled with multiple (previously separate) material agencies of bounded systems and / or services. Indeed, our case indicates that the new calendar would be most useful when multiple parties co-engage in a coordinated manner to attain virtual work that spans boundaries of conventional activities such as planning and scheduling, streamlining and coordinating efforts, archiving and information retrieval.

C. Ongoing and future research

In addition to the plainly evident benefits of the new calendaring service, it is worth noticing that by turning the calendar to an activity-oriented digital repository, tasks traditionally ascribed to digital repositories such as 'search and retrieval' may now be retrofitted to appropriate the new digital context. Thus, it is possible to search the repository to compile a list of events that satisfy designated search terms, while in a subsequent step, the search may be incrementally refined to allow digital collections of specific traces assigned (only) to these events. As a result, it is possible to compile dynamic and context-specific data sets without the need for special purpose querying mechanisms. This is currently being experimented in another case where the new calendar is used to provide a chronological log of daily activities of organic farmers as they carry out specific outdoor activities in the field and share their experiences (by uploading digital resources, raising issues and responding to requests) with others in a regional partnership [42]. In such a setting the calendar and the improved capacity for digital trace data management are extremely useful for retrieving task-specific information (i.e., who has completed certain tasks, what sorts of unexpected events have been encountered, by whom and where), but also for assessing team progress and roles amongst team members

(i.e., leaders, lurkers, moderators, etc.) and conditions determining the outcomes of the individuals.

D. Concluding remark

This paper has presented a scaffold for imbricating services and a concrete example of imbricating different web 2.0 services to facilitate family trip planning. The main contribution of the work is that it treats digitals services as materials which can be arranged in specific ways to serve human intentions.

Then, imbrication of services constitutes a design-oriented pathway that is primarily targeted to devising configurations of digital technologies so that two basic conditions are preserved, namely (a) the technologies operate interdependently and (b) the performative capacity and material agency of the imbrication exceeds those of its constituent materials. It is precisely this new material agency that causes changes in human routines and leads (ultimately) to new human capabilities as sketched in Figure 7.

The case of the re-invented calendaring service illustrates the viability of the method and provides convincing evidence of how a popular time scheduling artifact can be transformed to an activity-oriented digital repository by establishing linkages with and delegating special-purpose functionalities to previously separate digital services. In this manner, the entanglement of agencies creates new possibilities for action while the capability for managing cross-settlement digital resources makes it possible for users to understand why certain events exist, how they were brought about and what implications they raise.

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