Micro Workflow Gestural Analysis: Representation in Social Business Processes

Ben Jennings and Anthony Finkelstein

University College London
London, UK
b.jennings@cs.ucl.ac.uk and a.finkelstein@cs.ucl.ac.uk

Abstract. Enterprises are finding limitations with current modelling and hierarchical methodologies which have human agents as a key component. By requiring a priori knowledge of both workflow and human agents, when an unanticipated deviation occurs, the rigidity of such models and hierarchies reveals itself. This paper puts forward the position of an inversion of current approaches, in a real time context, by analysing the specific lightweight ad hoc processes, or flexible micro workflows, which occur in expert driven domains. Using gestural analysis of human agents within such flexible micro workflows in combination with social analysis techniques, new flexibility in business processes can be found. These techniques can be applied in differing expert driven problem domains and the resultant data from such analysis of gestural meta data can help to build a reputational representation of human agents within specific business processes, which will assist in finding the most appropriate human agent for a given task.

Key words: Workflow, Reputation, Identity, Representation, RMR, WFMS

1 Introduction

Business processes in many domains require human agent expertise. With the growth of Service Orientated Architecture (SOA) in the enterprise, integrating human agents into business processes is a focus of much work, based on hierarchical business structures and models built upon a priori data. The necessity to integrate human agents is often predicated upon the requirements of a process to react to uncertainty. The dichotomy of this methodology creates a schism between the desire to prescribe specific models and the stipulation for flexibility. Such rigidity in processes has led to the exploration in other areas, specifically that of open and social based software.

This paper puts forward the position that in some domains, specifically those that are expertise driven, applying a ridged hierarchical model may not result in the most advantageous results. By leveraging social software analysis, a different approach is possible, revealing a more subtle manner of lightweight ad hoc processes, or flexible micro workflow. Rather than presenting a specific architecture, this paper presents a grounding conceptual framework. From this foundation layer, a bifurcated analysis of human agent interaction with both data and other such agents can reveal new reputational data. This reputational data about human agents will reveal a basis from which to perform gestural analysis of human agent social intercommunication.

The rest of this paper is structured in five main sections. In the first section, business practices in relation to processes and social systems are examined. The second section looks at current business approaches with respect to human agents and classification. Sections three and four present a different social mechanism from which to gain new

insight into both the discovery and analysis of human agent reputation in the context of social interaction. The concluding section provides a final framing of the new social concepts presented in this paper and how they can provide the basis for a novel mechanism from which to create new social business processes.

2 Business Practices and Social Systems

Flexible workflow and related computer systems have been an area of research for over thirty years. As computer technology has advanced and massively networked systems have become readily available, the concept of what a computer system can provide, in the context of business processes, has shifted. This section of the paper will outline general trends in business processes, specifically as they related to human agents. The subsequent subsection will address the attention that is being captured by the possible application of social software techniques to business processes.

A fundamental concept, which emerges when looking at the work carried out in business processes, is that of creating abstractions to increase flexibility in the execution of work. In the early periods of the 70s and 80s, there was the shift towards design time execution via an abstracted modelling process. When computing resources became less constrained in the 90s and moving forward, there has been the shift towards run time execution of work via Service Oriented Architecture (SOA) and composition of services. A key component of this work has been human agents. Earlier work in this area looked at workflow support tools and SOA seeks to address human agents via a services metaphor such as a Worklist (see section 3).

Approaches in the space of the utilisation of human agents within business practices have, in the main, taken the position of complete domain and process knowledge. Working from the basis of full a priori knowledge an abstraction in the form of a workflow model or hierarchy of abstracted human agents would be created. Whilst in fixed criteria processes, where there is little ambiguity or unanticipated deviation, this approach is highly appropriate. In expert driven domains involving human agents, such a priori approaches lead to fragility of process. Business processes which are either poorly defined or are inherently not precise, such as in exploratory domains, perform sub-optimally when using these constrictive methodologies.

Nuanced human agent behaviour, whose nature is typical when working within an expert domain, can be seen to be problematic when using contemporary approaches to business processes, as has now been framed. A logical source of alternatives from which enterprises are seeking to draw would be that of the open social software domain. The next subsection will outline some of the potential in this area.

2.1 Enterprise Getting Social

Social software has many forms, such as wikis, blogging and micro messaging services. There are also strong social similarities within standardised software development tools, for example: mailing lists and ticketing systems. These similarities may be seen in the low barriers to entry: from commenting on a blog to signing up for a mailing list; and human agent to human agent communication working on a communal goal: collaboratively editing content on a wiki to produce a document to a discussions on a ticketing system as to the most effective solution for a bug.

There are two main facets of interest within the enterprise in relation to engagement with social software: direct interaction with customers and encouraging independence

of human agents within a business process. The first of these, direction interaction, may be seen as the call for "markets as conversations" [21] and serves to increase the potential value to both the customer and the provider, the provider in this instance being the process stake holders within the enterprise. This increased value may come from such interactions as eliciting feedback on products [7] or support for fellow customers [20]. This manner of interaction is not the main focus of this paper. The social software methodology which is the primary focus of this paper is that brought about by encouraging independence.

Much attention has been created by the success of such social productions from Wikipedia and the Linux project. In addition to the independence of process that these projects share, an additional feature is that of still having a supporting hierarchy. The *Linus doesn't scale* event [29] led to the creation of a supporting infrastructure hierarchy of *trusted lieutenants*. There is a similar notion within Wikipedia of the Wikipedians [3], a trusted subset of the contributors to the project with an addition of a maintenance role to ensure quality and reduce vandalism. Adopting social software practices does not inherently mean having an entirely flat hierarchical structure or process. Lowering the cost of entry by ad hoc flexible micro workflows encourages the bounded ecosystem to contribute but business processes can still maintain an underpinning process mechanism. There is now a sense of the problem space which flexible micro workflows looks to address. In the next section, contemporary approaches to the integration of human agents within business processes will be outlined. This will then form the basis for the requirement for a more flexible approach presented in section 4.

3 Top Down Thinking

A priori thinking has been touched upon in the previous section of this paper. This top down thinking is an evident pattern found when analysing business practices and has seen great success in many business domains. This section of the paper will present some of the strengths and weakness of this approach. The nature of human agents within business processes will be discussed, then the differential between processes, and where flexibility presents an issue. The last topic raised in this section will discuss the classification strategies commonly used in modelling and hierarchical approaches and how this leads to fragility in flexible business processes. This will put in context the lack of social interaction of the human agents within such a process.

A workflow is a formal, or implementation specific, representation of a business process. A business process has been defined as: "... any activity or group of activities that takes an input, adds value to it, and provides an output to an internal or external customer. Processes use an organization's resources to provide definitive results" [14]. This definition gives the notion of adding value to an input. Optimising processes for human agents, as mentioned above, is the focus of this paper. With the above definition, those human agents are those likely to be adding value to such a process, thus previous approaches to the integration of human agents will frame the discussion presented in sections 4 and 5.

3.1 Previous Human Integration

In the period of the 1970s to 1980s, when computer systems were first being applied to the problem of flexible workflows, there were initial hard constraints of the expense of computational power. This led to centralised decision support systems and interoffice

communication (groupware) being the first flexible workflow problem, in relation to human agent integration, to be tackled [19]. These first steps in integrating computer based systems to increase flexibility in workflow had issues such as brittle implementation, lack of interoperability and requiring too much upfront work by the users [11].

A wide variety of approaches to groupware solutions have been explored and it is beyond the scope of this paper to review them. Two brief examples show some significance of the issues from this period, those of computational expense: The Information Lens [22] was a tool that, via proprietary extensions to a mail server and email clients, allowed the users of the system to add meta data to email. Meta data could then be processed by rules on the client systems to automate some actions. This approach highlights the problem of computational power constraint, depending on human agents to do all of the processing. Increased upfront learning time for users will decrease the likelihood of adoption. This low adoption is due to the dependancy on custom client and server replacement software and the upfront user cost. There was also no sense of aggregation from this human annotation of data, or of mining social information from such data.

The second example from this period was a tool which was studied for potential deployment by Pacific Bell [4] called The Coordinator. This product was intended to combine group email, calendaring and word processing to improve focus on related conversations. The system highlights some of the problems outlined in this time period: difficulty learning the system due to limited interface, proprietary implementation leading to lack of interoperability and rigidity. With such a system one of the users reported frustration with the system ”worse than a lobotomized file clerk”. These two brief examples highlight a problem with the integration of human agents, that of prescriptive behavioural constraints. Rather than providing a low barrier to entry ad hoc approach, the systems enforce interaction mechanisms in a predetermined ridged manner.

3.2 Models and Abstracted Humans

From as early as 1977, putting abstractions in place to facilitate modelling of processes have been worked on in such examples as Business Decision Language (BDL)[12] and in Zisman's PhD work on office procedures [41]. Significant further work on this problem space has been carried out furthering the abilities and scope in the modelling of business processes [27, 30]. A more complete look at some of the evolution of the modelling abstraction in relation to flexible workflow is outside the scope of this paper but other work has been done in this area [18]. As business has shifted more of its core process components online, the ability to interconnect those parts became of more importance. The emergence of Service Oriented Architecture (SOA) enabled some of these requirements. By putting in place a clean, defined interface to logical units of work, interconnection of services was possible. The modelling concepts were extended by an industry driven modelling language called BPEL. With this extended modelling abstraction in place, a conceptual shift occurred within the actual steps of the business process. The abstractions free the workflow from specific interdependencies [13] in the parts of the workflow and allow interchangeable steps themselves.

Whilst the abstraction of steps within a business process model adapts well to computer service driven areas, human agent integration presents a more challenging issue. The most common approach to solving this problem is the integration of a so called Work List Web Service [6]. The general notion behind this concept is to present the services stack with a human agent abstraction as a Web Service, providing a generalised interface with which to interact. Other mechanisms have been used in order to capture human generated interactions [8], but the Work List metaphor, or variant thereof is

the most prevalent. Extensions to BPEL specifically targeting the modelling of human agents have been proposed, BPEL4People and WS-HumanTask [33], but are only at the initial OASIS procedural stages and look to model abstractions in a service context.

The SOA approach to human agent integration has a significant issue as it has no notion of finding the most appropriate human agent to perform a specific workflow instance. By abstracting away differing human agent abilities, other than in broad sub groupings of hierarchal structure, the very nature of expertise and social interaction is hidden. The last subsection in Top Down Thinking looks at the fundamental tenant of both modelling and hierarchical abstraction, classification.

3.3 Aristotelian Classification

Both previous subsections have essentially been focused on classification; in the case of subsection 3.1, the classification was focused on finding an abstracted sense of groups of human agents within a process and in subsection 3.2, a mechanism for classifying human agents into roles to be addressed as a generic service. Such generalisations can be seen as a top down approach to finding the fundamental nature of either the business process, or the human agent within such a process. Top down classification, or nesting, can be traced from the Aristotelian concepts [1] of categories as definitions in a tree structure. Rather than looking for individual traits of a specific instance of either an ad hoc process or a human agent, such nesting seeks to find an abstraction that can be fitting to many instances, so any agent or workflow found to fit into such a classification may serve equally well. This approach fits well with standardised computer modelling which tends to search for the general case.

The hierarchal modelling paradigm, while useful for deterministic production style business processes [23], captures neither specialisation nor enables unique or short lived ad hoc processes. Therefore a new paradigm needs to be included in current methodologies to facilitate more complex styles of interactions, particularly where interaction of expert human agents is required. In order to find the most appropriate human agent to carry out a specific task within a complex workflow, rather than creating broad generalisations in grouping of abilities, this paper proposes a bottom up ad hoc approach to classification via a flexible micro workflows metaphor in the context of meta data, or gestures, created by human agent experts in the execution of their work and by social interaction with fellow agents in larger business processes. The next section of this paper will present such a social conceptual space.

4 Flexible Micro Workflows

In the previous section of this paper (3), the normative approach to human agent analysis was put forward and some of the inherent limitations examined. In the next two sections of this paper, an alternative, multi-layered approach to social business processes will be presented. The first, flexible micro workflows, will examine a new method for the analysis of inter-agent activities. The subsequent section, Gestural Analysis, will present a bifurcated approach to the analysis of social interactions.

There is an asymmetry in the relation between the top down approach (see section 3) and the human agents engaged in the prescribed business process. The former provides modelling tools, process mining and hierarchies whereas the human agents performing specifically assigned ad hoc steps within a workflow are viewed in the manner of black boxes. The next subsection will describe the qualities of business domains which are

suited to the flexible micro workflow approach. From this domain foundation, hidden social productions will show an inverted view of black box opaque sub process. In the last subsection, an architectural approach and representational paradigm will be discussed, putting the application of flexible micro workflows in context.

4.1 Adhocracies

The traditional Service Oriented Architecture concept of ad hoc workflows tend to have a fixed concept space [5]. The architecture is based around the idea of an agent being able to either pick or create a sub workflow, or to delegate an assigned task. Other possible examples of such ad hoc workflows would be start, stop or defer for example [15]. Other non-SOA approaches can increase flexibility [2] but only via significant upfront disruptive costs via data training periods. Such flexibility would be entirely dependant on implementation and, with the state of current vendor technology, little or no interoperability would be possible.

The flexible micro workflows concept is based on two principles: no a priori knowledge and the assistance of domain experts in the execution of their work. As such, a flexible micro workflow may be defined as an expansion of a hitherto opaque node, within an exploratory domain complex workflow, whereby lightweight non-deterministic subprocess human agent interaction occurs, such as to facilitate the successful completion of said node. In the main, the standard business practices methodology comes from modelling, process mining or hierarchical creation, as mentioned in section 3. With design time abstractions, time would be taken by the workflow expert to ascertain the generalised, abstracted workflow model and, from that knowledge of the business process, to create the model or hierarchy. This is an entirely appropriate approach for many problem domains. The issue occurs when there is no perfect abstraction to reach, such as an exploratory model rather than that of a waterfall [35].

Expert Driven Domains and Flexibility In expert driven domains, or subsets of a larger workflow, where elements of expertise are required, rather than treating solely a step or node in a pre-modelled workflow as an atomic unit, flexible micro workflows suggest that there are many exploratory interactions which occur but are ignored by standard approaches, as they require a priori knowledge.

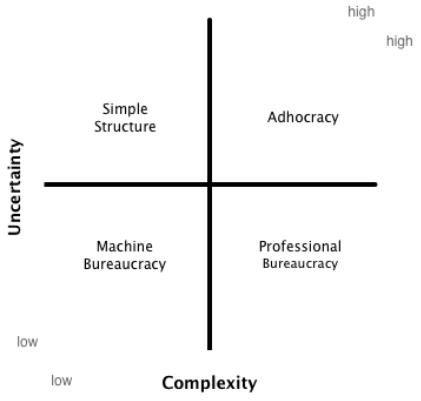


Fig. 1: Picture of high complexity and high uncertainty, based on work from [28]

As can be seen in diagram (figure 1), in an environment where there is high complexity and high uncertainty, an adhocracy [39] is the highly probable outcome. In an adhocracy, there is inherently the lack of a priori knowledge and therefore the need for a different approach to business processes, via the concept of flexible micro workflows. By creating a mechanism that will support such lightweight, ad hoc, quick fire human to human interactions, a different kind of flexible workflow can be revealed.

4.2 Prototype Theory

There is now a sense of the inverted approach of flexible micro workflows, in the context of human agents, and in which genre of business processes the approach would be suitable. Section 3 of this paper described the standard approach of analysing business processes from an a priori position in order to construct models and hierarchies. Those procedures are, in essence, looking to create a classification ontology on a given process. In this subsection, prototype theory[32] will be discussed in conjunction with a social extension, creating a different solution space for the flexible integration of human agents. Predetermined hierarchical structures in business processes have been discussed in section 3.3. Flexible micro workflows, rather than relying on an a priori analysis, put forward the position of building an ad hoc lightweight dynamic categorisation based on the analysis of human agents carrying out their work.

Prototype theory puts forward the position of looking at base-level categories rather than classical hierarchies as ”Most, if not all, categories do not have clear-cut boundaries” [40]. This position strikes clear resonance with current bottom up folksonomical strategies [24]. Flexible micro workflows looks to extend this with the application of social analysis, moving it into a multidimensional space [10]. Rather than finding a specific archetype of a business process or deriving an abstracted classification of a workflow with engaged human agents as an ancillary concept, flexible micro workflow looks to extend the prototype theory notion further. In expertise driven problem domains, building information around specific human agents enacting a given process, in the form of a layer of reputational meta data, will enable more flexible solutions when finding the most appropriate human agent for any given process. Reputation in the context of flexible micro workflows and Passive/Active Gesture Analysis (see section 5), refers to a body of data which can be acquired, analysed and represented programatically via a web service called Reputation-based Message Routing. The details of such a service fall outside the scope of this paper but are described in further detail elsewhere [17].

Many to Many Social Construct The support to the execution of ad hoc business processes poses two fundamental classification questions: what is the nature of the task? and who is the most appropriate human agent to execute such a task? Flexible micro workflows' proposed paradigm, in the context of human agents in an expert driven domain, effectively creates a many to many mapping. This concept moves the question from that of a predetermined hierarchy created by a small group of people, through the thought process of many possible types of a class, to the social state of an ecosystem of opinions on the nature of such a class.

Just as tagging via folksonomies gives a greater degree of flexibility to providing meta data over that of formal ontologies [26], the flexible micro workflows paradigm suggests a similar many to many relationship. Formal ontological work endeavours to find the one *best* classification for a specific object by an individual, or group, of experts. Folksonomies suggest that many classifications by many people provide greater

flexibility and insight into the objects and process. The classic representation of this idea comes from finding the specific Dewey classification for a new book in a formal ontology rather that of a digital representation of the same book being able to have many differing classifications. By removing the gating factor of physical limitations, new mechanisms are possible. Likewise in flexible micro workflows, rather than relying on a formal, hierarchical structuring of what is the one *best* workflow pattern, flexible micro workflows suggests a many to many, free flowing style of interaction provided by the human agents carrying out the work. The inverted concept behind the flexible micro workflows addresses the business requirements for increased flexibility in ad hoc processes and the desire to leverage social knowledge in a wisdom of crowds manner [38]. The next section will address where such social data can be mined and a bifurcated approach to the analysis of such data.

5 Passive/Active Gesture Analysis

Passive/Active Gesture Analysis, or PAGA, is an inversion of the normative behaviour when looking at human agents and flexible business processes. In the previous section, the concepts of flexible micro workflows were introduced. From this basis, Passive/Active Gesture Analysis and the inherent human and socially focused approach will be discussed and potential usage examined. The next subsection will present a bottom up approach to the analysis of human generated data in the context of flexible micro workflows which were presented in the previous section. From this basis the subsequent subsections will identify the notions and differentiation between passive and active gestures rather than a single source style aggregation of a distributed voting system [31]. In the final subsection, the notion of a representation of such gestures in the domain of a RESTful architecture will be outlined in relation to potential WFMS integration.

5.1 Hidden Social Production

Social production, in the context of business processes, may be viewed as the product of an assertion made by a human agent in the execution of an assigned task. There is another facet of human agent activity which, when used in aggregate, help to reveal a broader context from which to infer reputational data about specific human agents. It is important to note that in any such work where a system, or group thereof, is addressing specific human agents within a complex set of systems and workflows, identity must be a primary factor. Such a digital identity resource approach is outside the scope of this paper but has been examined in details with a practicable approach in another work [16]. This subsection will now look specifically at differentiating active and passive gestures.

Active Gestures Typical data artefacts which may be present in a business process interested in adopting social software might be: a wiki, blogs, group ticking systems, cvs, mailing lists and micro messaging services such as Twitter or the open source clone, Laconica. Three simple examples of an active gesture, within the context of social production, could be: the addition of content to a wiki system within a business process, the annotation of a data object via a tagging mechanism and the process of RT (re-tweeting) a micro message of a co-agent to promote the content of the message.

Passive Gestures Passive gestures can help bring a broader context to those of active gestures. Whereas active gestures focus on specific assertions made by an individual within the execution of a step within a business process, passive gestures may be seen as the consequence of the execution of work. Looking at the examples of social software listed above, three examples of passive gestures might be: analysing who emailed whom within mailing lists, analysing which blog posts are interacted with via a commenting mechanism and the process of reassigning a specific ticket to another human agent. This form of gesture may also be viewed as a form of ambient analysis as it looks for the patterns of human agent data generated in passing.

Passive/Active Gesture Analysis looks to combine the analysis of both of these forms of data. This approach has two benefits: the first is a broader context of data relating to a specific human agent or group thereof, the second is that by combining assertions and observed behaviour the analysis will ameliorate reciprocal behaviour. Such unchecked reciprocity could lead to human agents gaming any reputational metrics within a system for mutual benefit.

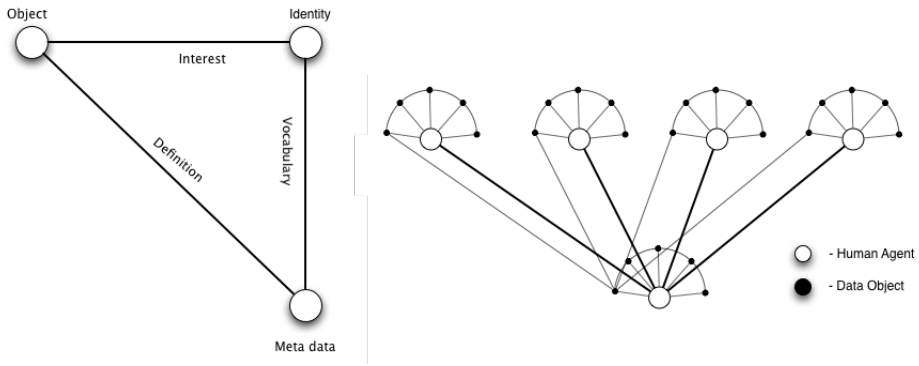
5.2 Densely Connected Microcosm

There is now a clear sense of the differentiated sources of data provided by the Passive/Active Gesture Analysis approach and where such data might be obtained within a human agent centric business process. The next two subsections will look first at the interconnectedness of such data and secondly how such data can be represented within a WFMS.

Hierarchical methods as mentioned in section 3, lead to a *vertically* orientated pattern of information flow, from the designer down to the bottom of the pyramid to the human agents executing the actual business processes. This can lead to situations, particularly in expert driven exploratory domains, of the model mismatch problem. Utilising the inverted approach suggested by Passive/Active Gesture Analysis, the method only concerns itself with the person to person communication in a densely connected *horizontal* manner. By enabling expert human agents to interact in a quick fire, ad hoc manner to form transitory workflows, a new kind of flexibility is revealed. The dense horizontal connectivity applies to that of relationships between human agents and to the data with which they interact.

In the tripartite graph (figure 2a), it is possible to see the relationship between the gestures of a human agent and the data object with which they interact. The meta data can be obtained either by a passive or active gesture analysis of that agent, through a tagging mechanism or by observational data. When this dense connectivity is applied to all data objects and all human agents within the ecosystem, a deeper level of connectivity may be observed. The definition informs not only the individual and aggregate view of what the data object is but also, from that same definition, it is possible to infer the very nature of the human agents interacting with the system.

In the connectivity arc (figure 2b), the deep relationship between the creators of the data and the data itself may be seen. A deep level of nodal connection density is only revealed via an analysis of flexible micro workflows. Such a concept takes the ability of being able to execute further a workflow based on a loosely or partially specified model [34]. By utilising an inverted paradigm, rather than a traditional hierarchical abstraction, the flexible micro workflows concept optimises for direct, quick fire, human to human interaction [37] and subsequently utilises this gestural data as a basis for reputation calculations.



(a) Identity Picture (b) Connectivity Arc Diagram

Fig. 2: Nodal Relationship

5.3 Representation of Social Resources via Reputation

With the structure of flexible micro workflows in place and the bifurcated data analysis suggested by Passive/Active Gesture Analysis, the open question of how such information can be represented and integrated within the context of existing WFMS remains. Whilst giving specific technical architectural details are outside the scope of this paper, this subsection will give a brief overview of the suggested approach.

There are a variety of metrics that gestural data could use to build reputation profiles dependant on the quality of domain. Such analyses could look at: *freshness*, *popularity*, *velocity* or *clustering* via a *friend of a friend (FOAF)* view. To expand upon *velocity*, in the example given in section 5.1, an analysis could look at the rate of RT (re-tweet) on a specific topic within a business process and which agents were interacting with such a RT in a given unit of time. From this basis, a system could infer related areas of reputation and which human agents within a given flexible micro workflows were responsible for the propagation thereof. Taking a broad approach to the methods of PAGA, will assist in mitigating potential Matthew Effect [25] issues.

RESTful and WFMS Integration with existing business processes is essential for any new approach to gain adoption. The flexible micro workflow approach looks at existing and new socially produced data and as such works in adjunct to such tools. Whilst specific implementation details are outside the scope of the conceptual framework of this paper, the technical foundational layer will now be highlighted. In the work by Fielding on Representational State Transfer (REST) [9], there is notion of a lightweight architecture describing how resources are addressed and specified. The flexible micro workflows approach, in conjunction with Reputation-based Message Routing (see section 4.2), uses the REST concept of a URI (Uniform Resource Identifier). The process of providing a programmatic resource of social data from the perspective of any human agent within the system will provide a valuable component to any flexible micro workflow. Using and extending the URI makes interoperability with any legacy system trivial as all that is required is a simple HTTP call, rather than any WS-* SOA middleware.

By creating pockets of flexibility within a larger business process, the flexible micro workflow concept, in conjunction with Reputation-based Message Routing, highlights a new type of lightweight, ad hoc, human to human communication. The inversion in the

hierarchy of experts provided by such an approach helps capture the nuance of human communication style in flexible processes and builds on the wisdom of the individuals executing a business process in a flexible domain: ”When it really comes down to the details of responding to the currents and handling a canoe, you effectively abandon the plan and fall back on whatever skills are available to you”[36]

6 Conclusions and Future Work

This paper has identified the need for a new paradigm when looking at lightweight business processes in the context of expert driven domains. This form of lightweight ad hoc business process, or flexible micro workflow, presents a rich ground from which to create new business value by increasing flexibility and building on the expertise of individuals.

Leveraging social assets such as blogs, wikis, micro messaging and traditional development interactions, provides a rich ground from which to perform social and human agent centric analysis. These passive and active gestures (PAGA) when used in combination and aggregate, can form the basis for novel styles of analysis in the context of flexible business practices, such as velocity or FOAF. From such information, a rich reputational layer of meta data can be created and presented as a programmatic resource representation of both workflow instance and specific human agent.

The extension to this work is to create a full system, supporting such lightweight interactions. Such a system would create the notion of a reputation metric around *all* human agents within the ecosystem of interacting business processes and would provide an architecture to enable rapid intercommunication between human agents. Reputation would, in part, be derived from PAGA which would, in turn, be based upon data mined from flexible micro workflows. A reputational system would both support and help in the execution of more social and human centric bottom up business processes.

References

1. Aristotle. The metaphysics. page 322, Jan 1991.
2. A. Bernstein. How can cooperative work tools support dynamic group process? bridging the specificity frontier. ... *2000 ACM conference on Computer supported cooperative work*, Jan 2000.
3. S. Bryant, A. Forte, and A. Bruckman. Becoming wikipedian: transformation of participation in a collaborative online encyclopedia. *portal.acm.org*, 2009.
4. R. Carasik and C. Grantham. A case study of cscw in a dispersed organization. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 61–66, 1988.
5. D. Chappell. Understanding bpm servers, 2004.
6. K. Clugage, D. Shaffer, and B. Nainani. Workflow services in oracle bpel pm 10.1.3, 2006.
7. C. Dellarocas. The digitization of word of mouth: Promise and challenges of online feedback mechanisms. *Management Science*, Jan 2003.
8. G. Faustmann. Configuration for adaptation–a human-centered approach to flexible workflow enactment. *Computer Supported Cooperative Work (CSCW)*, Jan 2000.
9. R. Fielding. *Architectural Styles and the Design of Network-based Software Architectures*. PhD thesis, 2000.
10. P. Gärdenfors. Conceptual spaces: The geometry of thought. *books.google.com*, Jan 2000.
11. J. Grudin. Why cscw applications fail: problems in the design and evaluationof organizational interfaces. *Proceedings of the 1988 ACM conference on Computer-supported ...*, Jan 1988.

12. M. Hammer, W. Howe, V. Kruskal, and I. Wladawsky. A very high level programming language for data processing applications. *Communications of the ACM*, Jan 1977.
13. Y. Han, A. Sheth, and C. Bussler. A taxonomy of adaptive workflow management. *Workshop of the 1998 ACM Conference on Computer Supported . . .*, Jan 1998.
14. H. Harrington. . . . process improvement: The breakthrough strategy for total quality, productivity, and competitiveness. *books.google.com*, Jan 1991.
15. A. Iyengar, V. Jessani, M. Chilanti, and S. B. . . . . [book] websphere business integration primer process server, bpel, sca, and soa. *IBM Press*, Jan 2008.
16. B. Jennings and A. Finkelstein. Digital identity and reputation in the context of a bounded social ecosystem. *Proceedings of BPMS2*, page 11, Jul 2008.
17. B. Jennings and A. Finkelstein. Flexible workflows: Reputation-based message routing. *CAiSE, BPMDS*, page 10, Apr 2008.
18. B. Jennings and A. Finkelstein. Service chain management: Flexible workflows. *Springer*, 2008.
19. P. Keen. Decision support systems: the next decade. *Decision Support Systems*, Jan 1987.
20. R. Kling. Social relationships in electronic forums: Hangouts, salons, workplaces and communities. *Computerization and controversy: Value conflicts and social . . .*, Jan 1996.
21. R. Levine. [book] the cluetrain manifesto: The end of business as usual. *Da Capo Press*, Jan 2001.
22. T. Malone, K. Grant, K. Lai, R. Rao, and D. Rosenblitt. The information lens: An intelligent system for information sharing and coordination. *Technological support for work group collaboration*, Jan 1989.
23. P. Mangan and S. Sadiq. On building workflow models for flexible processes. *Proceedings of the 13th Australasian database conference- . . .*, Jan 2002.
24. A. Mathes. Folksonomies-cooperative classification and communication through shared metadata. *Computer Mediated Communication*, Jan 2004.
25. R. Merton. The matthew effect in science the reward and communication systems of science are considered. *Science*, 159:56–63, Sep 1968.
26. D. Millen, J. Feinberg, and B. Kerr. Dogear: Social bookmarking in the enterprise. *Proceedings of the SIGCHI conference on Human Factors in . . .*, Jan 2006.
27. R. Milner, J. Parrow, and D. Walker. A calculus of mobile processes-part i. *topps.diku.dk*, Jan 1990.
28. H. Mintzberg. [book] structure in fives. *Prentice-Hall Englewood Cliffs, NJ*, Jan 1983.
29. G. Moody. Rebel code: the inside story of linux and the open source revolution. page 344, Jan 2002.
30. C. Petri. Communication with automata. *stinet.dtic.mil*, Jan 1966.
31. P. Resnick, K. Kuwabara, and R. Zeckhauser. Reputation systems. *portal.acm.org*, Jan 2000.
32. E. Rosch. Cognitive representations of semantic categories. *Journal of Experimental Psychology (General)*, Jan 1975.
33. N. Russell and W. Aalst. Work distribution and resource management in bpel4people: Capabilities and opportunities. *LECTURE NOTES IN COMPUTER SCIENCE*, Jan 2008.
34. S. Sadiq, W. Sadiq, and M. Orlowska. Pockets of flexibility in workflow specification. *LECTURE NOTES IN COMPUTER SCIENCE*, Jan 2001.
35. I. Sommerville. *Software Engineering*. 2006.
36. L. Suchman. Response to vera and simons situated action: A symbolic interpretation. *Cognitive Science: A Multidisciplinary Journal*, Jan 1993.
37. L. Suchman. Plans and situated actions: The problem of human-machine communication. *books.google.com*, Jan 1994.
38. J. Surowiecki. *The wisdom of crowds: why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations*. 2004.
39. A. Toffler. *Future Shock*. 1970.
40. D. Weinberger. Everything is miscellaneous: the power of the new digital disorder. page 277, Jan 2007.
41. M. Zisman. [book] representation, specification and automation of office procedures. *University of Pennsylvania*, Jan 1977.