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Recommended Citation

Butler, Tom; Emerson, B; and McGovern, D, "Pragmatic Design: A Case Study of Innovation in a Small Software Company" (2008). *ECIS 2008 Proceedings*. 117.

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PRAGMATIC DESIGN: A CASE STUDY OF INNOVATION IN A SMALL SOFTWARE COMPANY

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Abstract

The research question that underpins this paper is ‘What are the novel features of IS design practice ‘in the wild’? In order to help answer this question, a theoretical perspective that focuses on practitioners’ ‘situated practical theory’ in the ‘co-production’ of IS designs is adopted. The context for this study is that firms operating in the IT sector face particular challenges in navigating the complex web of global regulatory requirements. Accordingly, practitioners indicate the need for IT artefacts to informate and help automate compliance processes in organizations. This paper reports on the design of an innovative IT artefact called Compliance-to-Product (C2P), which is argued to be in the vanguard of a new breed of IS called Compliance Knowledge Management Systems (CKMS). The paper describes how this IT artefact was designed by a small-to-medium sized software enterprise, whose design architecture originated in the ‘situated practical theory’ of the company’s founder. However, the findings illustrate that the detailed design was ‘co-produced’ by a network of social actors from collaborating organizations and that this emerged over time. The paper’s concluding observation is that the findings pose a question for design science and the claims for its ability to shape design practice.

Keywords: Design, IT Artefact, Compliance, Knowledge Management, Case Study

1 INTRODUCTION

Small-to-medium sized software enterprises (SMSEs) are argued to be wellsprings of innovation (Baskerville & Pries-Heje 1999). In Ireland, for example, there are in excess of 900 software enterprises, approximately 95% of which may be categorised as SMSEs, as they employ less than 49 staff (National Software Directorate 2000). In a wider context, the European Commission (2002) found that such firms generate significant employment, productivity, and economic growth. Nowak and Grantham (2000) echo point this in a US context and argue that software firms lie at the heart of the knowledge economy in that they provide “the enabling tools and infrastructure to IT professionals in virtually all other industries”. As with the European Commission’s findings, Nowak and Grantham emphasise the ubiquity and importance of small niche market entrepreneurial software enterprises. Yet despite the growing importance of the sector, Bernroider (2002, p. 563) points out that the “software industry has received surprisingly little attention, given the size of the industry, its rapid growth and apparent importance.” While this comment is not specifically targeted at the IS discipline, it is, nevertheless, applicable, especially in respect of the dearth of research on the design of IT artefacts by SMSEs.

The objective of this paper is to explore the design of IT artefacts ‘in the wild’ through a longitudinal case study of one small small-to-medium sized software enterprise. The following section outlines this study’s theoretical perspective. It argues that innovative software designs by SMSE’s are a function of knowledge acquisition aimed at solving ‘wicked problems’. Such problems are, according to Hevner, March, and Park (2004), characterized by (a) imprecise requirements and uncertainty in environmental contexts; (b) complexity in the constituent elements that contribute to the problem’s solution; (c) flexibility in the processes underpinning the design and in the resultant IT artefacts; (d) creativity in the design team; and, finally, (e) teamwork. However, we argue that software design ‘in the wild’ is a multifaceted social process in which the knowledge required by SMSEs to design innovative IT artefacts is ‘co-produced’ in a complex social matrix that transcends the immediate design team. The fundamental research question underpinning this study is, therefore, “*What sources of knowledge contribute to the ‘co-production’ of the IT artefact design by helping an SMSE to solve the aforementioned ‘wicked problems.’*”

It is clear from practitioners and researchers in reference disciplines that there is a dearth of IT artefacts to help organizations address what is a significant challenge in meeting the challenges posed by global environmental regulations (Kerrigan & Law 2003, Avila 2006). Thus, this paper focuses the design of an IT artefact to support business enterprises in the high-tech sector to manage environmental compliance imperatives and to minimize related risks. The paper describes in context: (a) the conceptual model for the Compliance-to-Product as a Compliance Knowledge Management System (CKMS); (b) the IT architecture for the CKMS; and (c) the features of functions of the C2P application IT artefact as employed in the pilot implementation of C2P at Napa Inc. This evaluation by Napa Inc. provides empirical support for the claims made for C2P’s ability to maximise compliance and minimise risk.

1.1 Theoretical Perspective

This paper’s theoretical perspective on the design of IT artefacts draws on that of Butler and Murphy (2007), who argue for the role of ‘practical theory’ and perspectives from phenomenological hermeneutics in studies of IS design. The point of departure for this theoretical perspective into of the nature of design practice comes from Brooks (1989, p. 17) who argues that “[g]reat designs come from great designers. Software construction is a creative process. Sound methodology can empower and liberate the creative mind; it cannot inflame or inspire the drudge.” In keeping with with much of postmodern philosophy, Brooks puts emphasis on the primacy of practice over theory and method. Butler and Murphy (2007) illustrate that Hans Georg Gadamer’s (1975) phenomenological hermeneutics is seminal in this regard. Gadamer, for example, draws on Aristotle, to argue that a social actor’s ‘practical knowledge or wisdom’ (phronesis) is a synthesis of his/her temporal

experience of social phenomena with an ability to perform practical actions in the social world. This is to be contrasted with skills-based knowledge (*techne*), scientific theory (*episteme*), philosophical wisdom (*sophia*), and intuitive reason (*nous*). According to Gadamer, *phronesis* cannot be learned or forgotten, is ethical in character, and has an overarching influence on individual action. Furthermore, Gadamer indicates that theoretical knowledge (as *sophia* or *episteme*) and skills-based knowledge (*techne*) are both informed by, and therefore secondary to, ontologically speaking, the experiential or ‘practical knowledge’ (*phronesis*) of social actors—this observation has implications for design theory.

Knowledge acquisition is argued to be vital to the success of small, innovative high-technology enterprises (DeCarolis & Deeds 1999). Hence, Nowak and Grantham (2000) maintain that small-to-medium software enterprises need to form partnerships if they are to overcome the limitations of their firm-specific knowledge. This point of view is echoed by Taplin (2006) and Terziovski (2003) who highlight the long-standing recognition of the important ability of small high-tech firms to develop R&D networks, joint ventures, and partnerships, to access wider sources of ‘practical’ and ‘skills-based knowledge’ to help them innovate, and to exploit their innovations. These claims on the importance of networks and alliances in fostering innovation are also made in respect of large successful software firms (Iyer & Lee & Venkatraman 2006).

This paper therefore presents the following propositions:

- Practitioners’ ‘situated practical theory’ is a function of the application of ‘*phronesis*’ and ‘*techne*’.
- Designers’ ‘situated practical theory’ aims to inform the design of IS whose purpose is to repair the ‘breakdowns in understanding’ of users.
- ‘Great designers’ will play pivotal roles in the design process.
- Innovation in the design of software artefacts is a function of knowledge transfers in social and inter-organizational networks and contexts that enhance the ‘*phronesis*’ and ‘*techne*’ of practitioners in SMSEs.

2 PARTICIPATORY RESEARCH ON AN IT ARTEFACT FOR COMPLIANCE KNOWLEDGE MANAGEMENT

An exploratory case study design was chosen for the study (Yin 2003), as the research collaboration between the researchers and Compliance and Risks (C&R) Ltd. did not meet the criteria demanded of action research (Baskerville 1999). While the participating university researchers had extensive knowledge of KM practice and software design techniques, C&R practitioners’ “situated, practical theory” (Baskerville 1999, p. 17) informed the overall design of the C2P application; the researchers did, however, apply their architectural knowledge and participate in making certain decisions on the underlying IT architecture.

The two university researchers participating in this study were former IT practitioners with over 40 years experience between them. Four practitioners from the company played an active role as “co-researchers”. The primary co-researcher was the Irish founder of Compliance and Risks Ltd., who was the inventor of the underlying management method (patent pending), while the secondary co-researchers included the Californian-based software team’s project manager and C2P’s chief design architect; a senior software engineer from C&R; and the company’s Marketing and Sales Director. The majority (7) of the development team were headquartered in Northern California, with 2 being based in Europe. The company’s Legal Data Team were primarily European based; however, it did have a number of lawyers working out of US offices. The remaining participants included users of the pilot version of C2P at Napa Inc. in Silicon Valley.

The data for the present study was gathered using semi-structured interviews and during numerous meetings and on-site visits in Europe and the US, spanning the period from August 2005 to August 2007: participant observation was also employed throughout (Yin 2003). It must be noted, however, that researchers had no access, at any time, to confidential client data, in accordance with C&R's non-disclosure and confidentiality obligations to its clients. Internet-based teleconferencing technologies were also employed to facilitate meetings, in addition to emails and instant messaging. The data was interpreted and analyzed on an ongoing basis and augmented by official company documentation, including Compliance and Risks' business plan, training manuals, technology architecture documentation, and so on.

3 COMPLIANCE-TO-PRODUCT (C2P) AS AN INNOVATIVE IS SOLUTION TO RISK MANAGEMENT

Environmental concerns have led to a growing emphasis on compliance issues surrounding the use of hazardous substances across all industry sectors (Kellow 2002, Hristev 2006). Such regulatory pressures are particularly evident in the high-tech manufacturing sector, where there widespread use of materials and substance that are deemed hazardous to the environment and human health (Avila 2006). In a recent study conducted by The Aberdeen Group, it was revealed that nearly 80% of companies lack a cohesive systems infrastructure to track, audit or manage product compliance. Most companies are relying on a variety of solutions that are not properly integrated and do not provide the necessary information needed to meet the current and future environmental regulations (Aberdeen Group 2006). Kerrigan and Law (2003, p. 126), for example, argue that an IT artefact, "if properly designed and developed, has the potential to mitigate and help solve many of these complicated issues." Such a system would permit users to anticipate, plan, and track compliance initiatives, taking into account, existing and proposed regulations (Sammer 2005, Avila 2006)—that is, in Butler and Murphy's (2007) terms, to help repair the 'breakdowns in understanding' that arise in interpreting complex regulatory imperatives on a global basis.

Compliance and Risks Ltd founder's experience in regulatory intelligence for Deloitte in Brussels gave him a unique perspective on the need for, and potential of, Compliance Knowledge Management Systems (CKMS), especially in those industry sectors affected by environmental regulations being introduced by the European Union. Thus, he identified the high-technology, electrical and electronic sectors as potential niche markets for his new business method and CKMS innovation. An early, but ultimately problematic collaboration with a Brussels-based R&D company, and the initial participation of Napa Inc. in the requirements gathering, saw him develop a conceptual model of the components and processes of an enterprise-wide Compliance Knowledge Management System (CKMS) called Compliance-to-Product (C2P) —this is now outlined. In terms of this study's theoretical perspective, the knowledge network that underpinned innovation in this nascent software company thus grew in response to an industry need and included several actors. Furthermore, the knowledge there gained (i.e. the *phronesis* and *techne* of the company's founder) was made explicit in the conceptual model.

3.1 The Compliance Knowledge Management System Conceptual Model as Situated Practical Theory

Compliance and Risks views an Enterprise Compliance Knowledge Management System as being enabled by an integrative IT artefact that manages all enterprise compliance processes, i.e. assessing and managing compliance-related issues, risks, and tasks, communication, collaboration, document management and disclosure. The CKMS must also support product stewardship. Most important, however, is that it must present all external regulatory requirements impacting an organization, including, for examples, environmental regulations, to public procurement, tax, company law, import/export, advertising, warranties, anti-trust, transportation, health and safety, quality, corporate and social responsibility, and so on, in the context of evolving, strategic internal requirements. The conceptual model of the Compliance-to-Product (C2P) CKMS posits three high-level process

groupings: External Requirements Gathering Processes, Enterprise Compliance Processes, and Enterprise Knowledge Management Processes, with three primary categories of users—Legal/Subject Matter Experts; Industry Experts; and users from an Organization’s Compliance Function and managers and engineers in the product R&D/Manufacturing/Logistics functions (see Figure 1).

Practitioners at Compliance and Risks Ltd. argue that understanding and contextualizing regulatory and legal compliance imperatives requires sense making, which is informed by a deep knowledge of the way in which such imperatives develop over time, and are applied in different ways across diverse regulatory jurisdictions. Hence, they argue that due to the complexity of global regulatory environments, External Regulatory Requirements Gathering Processes require the active participation of legal and industry experts. These individuals capture all relevant data on the jurisdiction, instrument type, and legal basis for the compliance imperatives identified by them as impacting on the IT, electrical and electronic manufacturing sectors. Consequently, the scope of External Regulatory Requirements Gathering Processes covers all of the regions in which relevant firms operate; these include, for examples, juridico-political territories and the predicted regional implementation areas of environmental compliance imperatives. Additional complexity arises in the external environment as compliance imperatives often fork into distinct regulatory requirements in parent-child configurations, in which the resulting ‘child’ imperative may differ in terms of the criteria applied to business processes, behaviours, service and products. Thus, it became clear to practitioners at Compliance and Risks that few, if any, organisations had the internal legal expertise to manage the complex, global regulatory environment, and that large manufacturing organisations were having extreme difficulty in tracking and monitoring regulations identified for them by external legal entities. Thus, it was apparent that such organisations were experiencing enormous problems in codifying and managing all relevant legal and compliance data and in capturing the often subtle differences between them. This was particularly so in dealing with EU Directives, especially when member states ‘gold plated’ legislation to make it more or less restrictive in order to favour national industries.

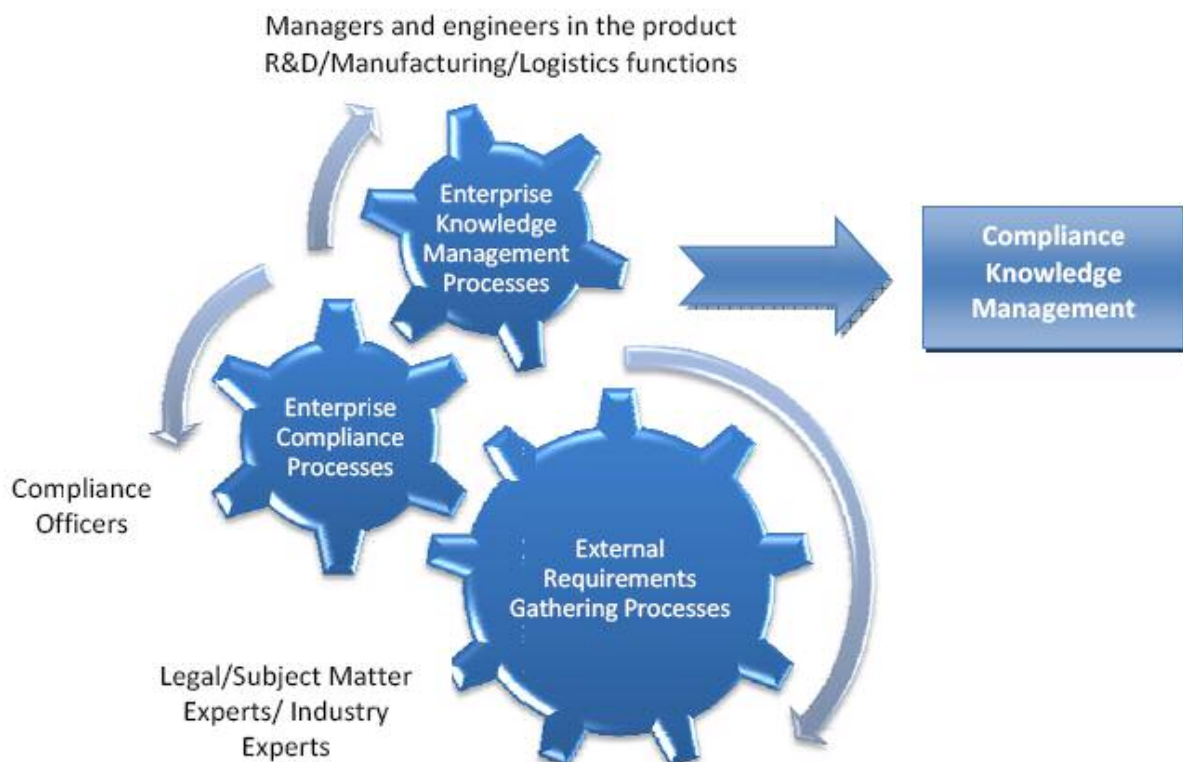


Figure 1 CKMS Conceptual Model

The C2P model indicates that once External Regulatory Requirements Gathering Processes capture, properly format and store compliance imperatives, they are made available to organizational compliance officers/product design engineers. Thus, it was planned that features of the C2P application

would enable compliance practitioners to readily assess and manage regulatory requirements and to deal with product-related risks and issues. These processes are enhanced by communication and collaboration features that support Knowledge Management by enabling users to automate information sharing (e.g. by triggering risk alerts when legislation is modified or compliance imperatives are modified or newly introduced) and to informate the compliance implementation process. Finally, the C2P Repository was designed to store (a) compliance imperatives (e.g. legislation, case law, standards, guidelines) emanating from diverse global regulatory environments and global/local, parent/child relationships within and between such regulations; (b) organisation-specific compliance data; and (c) a knowledge repository containing contextual information.

A future version of the CKMS will enable automatic linkages between regulatory compliance imperatives and the internal organisational processes, services, products, and components/materials being regulated. To achieve this demands the eventual automation of the processes outlined herein. This was, however, planned from the outset, and C&R's first R&D partner argued that it could be achieved through the use of an ontological approach to development using the Mercury programming language. This would enable products (once their attributes were input by design engineers) to map onto compliance imperatives—C&R conceptualize this as the ability “to grow the mind of the product”. Problems ensued with this approach, however, and these are explained below.

3.2 Identifying Design Problems (Aug-Sept. 2005)

In 2005, existing and potential competitors were not serving the compliance needs of manufacturing firms; hence, an opportunity to gain a competitive advantage existed through the adoption of a first mover strategy. Recent feedback from Deloitte's Governance, Regulatory and Compliance division confirmed that this is still the case in late 2007. Pre-product marketing had Napa Inc., an IT-based Fortune 500 company, undertake to pilot-test the first version of the application; this was a reflection on the absence in the marketplace of IT artefacts with CKMS capabilities—thus, the Compliance-to-Product (C2P) application came into being. However, by the Summer of 2005, C&R's original strategy of using Ontology-Based Development and the use of the highly obscure Mercury programming language to develop the C2P application was not achieving its objectives. As indicated, this approach to the detailed design of the IT artefact was the brainchild of the company's first R&D partner, based in Brussels. In brief, the delivery of the pilot application for Napa Inc. was just 9 months off and the application was not taking shape, in terms of with form or function. Furthermore, potential customers in industry were raising concerns about the ontologies/Mercury-based technology, particularly the fact that it was non-standard and not widely proven. Thus, C&R needed to know if standard industry-wide technologies such as J2EE or .NET and RDBMS, like Oracle and MySQL, were inferior or superior to ontology-based solutions and whether it would be possible to use a mix of the technologies (e.g. a J2EE-based solution informed by ontology-based design concepts) to give C&R a competitive advantage. Industry acceptability of the technology on which C2P was constructed was of paramount importance.

The university researchers were invited to investigate the sources of the problems facing Compliance and Risks Ltd. in August and September 2005. At this time, the Californian design team had gathered detailed requirements for the prototype from Napa Inc. They had also constructed a comprehensive set of requirements specifications, the core of which was a well-designed, sophisticated data model. Given that the source of C&R's then problem was with the Belgian development partner and its idiosyncratic development approach, one of the researchers travelled to Brussels to study, on-site, the prototype C2P application. He also reviewed all project related documentation, and to interview the team undertaking the development using the Ontologies/Mercury approach. It was clear from this initial element of the study that the Ontologies/Mercury combination was an inappropriate technology on which to base a web-based, enterprise-wide application. One of the major problems was that the Belgian development partner failed to implement the database design specifications produced by the Californian team in full; one reason given for this was that the design specification was not congruent with the ontological development approach chosen. The results were unsatisfactory, both to C&R and its Californian design partner, who voiced reservations about the development approach being taken in Brussels to build the prototype. These concerns were justified, as the researchers found, for example,

that the C2P prototype's data repository consisted of a single table, which when scaled up to store real-world data, would prove a significant performance bottleneck for the system. Design and performance problems were also evident in the web interface. It was also apparent that the any system based on the prototype would not integrate well with other enterprise technologies. Thus, no matter how attractive the application appeared in terms of academic-based design theory, its implementation in practice would not see the technology adopted by standards-driven, global business enterprises.

It was also apparent to the university researchers and their practitioner co-researchers at C&R that the Belgian-based R&D team's objective of providing a 'silver bullet' for the software crisis, through their advocacy for, and application of, ontology-based development and the Mercury programming language, ran counter to the company's objective of providing a working pilot CKMS for Napa Inc. The consequences of this diagnosis was significant for C&R, as the success of its nascent business depended on the delivery of a functional C2P application in mid-2006. The company therefore had to dispense with the services of its European R&D partner and effectively begin development of the application from the ground up.

3.3 Solving Detailed Design Problems (Oct-Nov. 2005)

One of the key inputs into the C2P application design from the practitioners' perspectives was the existence of a detailed design specification and data model for C2P. It, therefore, seemed logical for Compliance and Risks' to have its Californian-based design partner plan for and undertake the application's development—the question facing C2P was 'which development platform was most suited to C2P's requirements?' Following on from the university researchers' recommendation to abandon development using the Ontologies/Mercury approach, the researchers undertook to identify an alternative technology platform for the CKMS, to advise the company on the selection of a suitable platform, and to collaborate with its development partner on the development of its C2P application from scratch using the new platform. It was fortunate, and coincidental, that the university researchers had just completed the design and development phases of an action research study aimed at implementing a Web-based, enterprise-wide Knowledge Management System (KMS) for a large government department. This action research study commenced in March 2004 and the resultant KMS application was based on J2EE (Java 2 Enterprise Edition) and Open Source Software (OSS) technologies, such as Hibernate, MySQL, and, subsequently, Oracle 10g as the RDBMS. A review of the range of available development platforms, coupled with the researchers' experience in designing and developing the government KMS, led them to conclude that the J2EE and OSS technologies and conventional DBMS provided the necessary and sufficient building blocks for the creation of C2P, given the conceptual model described in Figure 1. This research phase highlighted, however, that ontology-based methods might be employed in conjunction with J2EE to provide inferencing capabilities required to implement the automated verification of product compliance described above, or should the problem domain prove to be overly complex. Thus, it was concluded that there was no practical reason why J2EE/Relational software engineering approaches should be considered technically inferior to the Ontology/Mercury pairing—although, in theory the latter should be superior.

Microsoft's .NET was also proposed by a potential customer as an appropriate platform. Industry support for J2EE over competing platforms such as .NET is found in an analysis by Datamonitor (2003), which reports that J2EE dominates in terms of its use by business enterprises for web-based enterprise applications in Europe. Similar findings are reported by Forrester Research (2005), who found that the majority of financial services organisations consider J2EE — and not .NET — to be the strategic enterprise development platform of choice. Thus, the researchers held that that J2EE could build a robust, reliable, enterprise-wide solution that will be accepted and adopted by businesses. Another reason supporting the selection of J2EE was that it was essential to provide the ability to support Microsoft Windows, Mac OS, Linux and UNIX (e.g. Sun Solaris) platforms for prospective customers. While .NET offered a robust development platform, it did not offer the native ability to support UNIX, Linux or Mac OS.

As it was a future objective of C&R "to grow the mind of the product" in order to effectively automate several of the internal enterprise compliance processes, it also therefore recommended that a future

version of the system could use an inference layer based upon concepts derived from the Semantic Web, RDF (Resource Description Framework) and OWL (Web Ontology Language). This might permit compliance imperative data to be queried in an intelligent manner and to display complex relationships present in the domain model beyond immediate data connections. For example, an entity may exist in the system for the chemical element lead, the use of which is restricted under RoHS regulations. Linking a specific product, such as a Napa IT device, directly to the element lead does not provide the system with any information on whether product sub-components contain lead, or whether other products within the same product category contain lead, or whether legislation which controls lead impacts upon the product or its sub-assembly. Providing the system with a definition of what lead is, linking this definition to compliance sources responsible for the control of lead via relationships, and building a product hierarchy using relationships to provide information on whether a component 'contains' lead or 'might contain' lead, allows the inference engine to determine whether a particular product is under the control of a particular legislation within a specific country or region, and which component in the product subassembly specifically triggers a compliance-related issue. In order to express these relationships and more, Compliance and Risks' founder, in concert with legal and IT practitioners, established a semantic lexicon of compliance-based terms and definitions that were confirmed and elaborated by compliance professionals at Napa Inc. It is notable that this was achieved using a combination of practical knowledge and common sense, rather than semiotic theory.

The remaining participative activities that the university researchers contributed to during this period were to help Compliance and Risks' to 'kick start' the development of the pilot version of C2P at Napa Inc. The key component in the Java-based C2P application was going to be its database, due to the complexity of the conceptual model's data elements (e.g. the complex data structures required to represent regulatory requirements as compliance imperatives etc.). Hence, it seemed logical to outsource the development of C2P to C&R's Californian partner—the problem, however, was that although highly competent and experienced in their own areas, the Californian team needed to be augmented with developers with competencies in J2EE and Open Source technologies. It was, therefore, significant that two senior software engineers, who worked with the university researchers in developing its KMS for the Government Department, were then available to participate in the C2P development project. On the recommendation of the university researchers they were retained by C&R. Thus they brought much needed experience in web-based Java development and in the use of Open Source technologies to the development of C2P. Furthermore, as employees of C&R, they would help the company retain valuable intellectual capital on how the application was developed. Thus, a virtual inter-organizational application development team was put in place to begin development of the C2P. The team was quite diverse, in terms of the experience of team members and their respective backgrounds and nationalities; however, such factors did not negatively affect the development of the application. While a team effort, with input from one of the university researchers (the former software engineer), it was undoubtedly the expertise of the chief design architect and project manager that helped translate the conceptual model, and its design specifications, into the successful C2P pilot at Napa Inc. An Agile Development approach, using elements of XP was also adopted to help hasten the development of a high-quality application.

3.4 C2P's Detailed Design and Build (Jan-Sept. 2006)

The primary action takers, in development terms, and driving force behind the successful implementation of the conceptual model and its implementation into the J2EE C2P application was, undoubtedly, the Californian-based project manager and his close-knit team. However, in order to further help accelerate the development of C2P, the university researchers made available the design schema of the J2EE-based KMS which resulted from their previous action research study. While the KMS design was not found to be applicable to the C2P problem domain, the overall architecture, certain features, and the use of Open Source technologies were instrumental in helping the Californian development team and its virtual team members from C&R 'steal a march' in terms of building the pilot version. The experiential knowledge of J2EE possessed by the two recently recruited C&R-based software engineers, augmented as it was by that of one of the university researchers, was instrumental in the successful adoption of C2P's Java-based architecture using Open Source

technologies. Nevertheless, action taking during this period was not confined to development, as practitioners in C2P continued to market and promote the concept and to build a team of legal subject matter experts to populate C2P's repository. Another outcome of these activities was that the company entered in to an agreement with Sonoma Inc., a Fortune 100 IT manufacturer, to adopt C2P to meet its global compliance challenges.

3.4.1 C2P Architectural Design

As previously indicated, the C2P application makes extensive use of Open Source Software, much of which had been tried and tested in the previous KMS action research study. Thus, a layered approach was taken to the design of the application. For example, the Data Access layer uses Hibernate to manage database transactions. Hibernate is a database independent object relational mapping framework. Any JDBC compliant database can be used with minimal configuration changes—this is an important consideration for large organizations tied to specific products, e.g. Oracle vs. SQL Server. The Manager Layer delegates access to model objects retrieved from the data access layer to the Controller layer, which processes business and workflow logic. Spring is used as the underlying framework for these two application layers. Spring is a lightweight dependency injection mechanism that externalizes the creation and management of component dependencies, ensuring that the application can be divided into disparate functional modules. The Presentation Layer supports clients using web browsers, mobile clients, and external web service consumers. The Controller and Presentation Layers were built around Jakarta Struts and Tiles, and uses JSP (Java Server Pages) with custom tag libraries as a view component. The basic architecture easily evolved into a service oriented architecture (SOA) to enable the company's Compliance-as-a-Service Business Model.

It is also significant that Semantic Web technology is being used as an inference layer in concert with Hewlett Packard's Jena framework in order to enable highly sophisticated semantic searches using RDF resources and OWL. Security in C2P is implemented using the Acegi security library, which is an enterprise level security module for the Spring framework. The application was built using Apache Ant, a Java-based build tool, which permits one-click deployments of the application as well as supporting the development process by providing automated builds and unit test runs.

3.5 Evaluating C2P Design at Napa Inc. (Sep. 2006- May 2007)

This section examines the outcomes of the pilot deployment of C2P at Napa Inc. using feedback from the company's compliance team and product engineers. Napa had adopted a rigorous five stage set of activities in order to help it manage compliance viz. (1) Track and monitor all relevant regulations in the global marketplace; (2) Assess all related risks in terms of process and product; (3) Raise awareness across the organization, especially in engineering/design/R&D and manufacturing, and enhance intra-organizational communications across all relevant functions; (4) Implement compliance solutions in engineering and design functions at the earliest possible opportunity; (5) Review the effectiveness of the steps taken and the level of compliance achieved. Prior to the adoption of C2P, these steps were increasingly proving to be difficult to manage in terms of the scope and complexity of the global regulatory environments in which Napa operates. Accordingly, practitioners at Napa cited product recall and exclusion from particular markets as some of the ongoing threats to the company. However, when Napa adopted and used C2P they found that, unlike other approaches, "source regulatory data is delivered pre-formatted, structured and ready to use out of the box" (Compliance Officer)..

C2P's ability to deliver "source regulatory data...out of the box" is based on design features that enable Compliance and Risks' Legal Data Team (LDT) capture and store all relevant legislation, along with contributions from industry experts. Both categories of users employ an easy-to-use web-based interface to process legal instruments into component compliance imperatives/regulatory requirements and related structured data that describes target organizations, geographic scope, any exceptions/exemptions, and the overall impact of the regulations. In order to achieve this, the application interface presents the LDT and Industry Experts with a *Terms and Definitions* feature that facilitates definition, interpretation, and analysis of legal and business terms—this is particularly

useful in clarifying, and distinguishing between, legal synonyms or homonyms and/or other terms which may introduce ambiguity or opaqueness to regulatory requirements for business users. A *Smart Link* facility also helps map the relationships between regulatory requirements and their impacts, activities on product families, down to individual products and component materials. The application is dynamic in that it facilitates frequent data updates and pushes new or modified/revised compliance imperatives to client organizations as *Alerts*. Thus, C2P and the LDT support the first two of Napa's processes: *Tracking and Monitoring* and *Assessing Risk*. Insights into the application's effectiveness in this is given by Napa's Compliance Officer who stated that C2P "gives instant, live snapshots on policy areas that are not adequately covered or understood—[it] helps guide management to allocate resources to appropriate risk areas" by allowing "group managers to assign large numbers of issues and tasks while maintaining a clear view on progress or change affecting both policy and product."

In terms of making critical decisions, Napa Inc. can now view the *Impacts* of compliance imperatives in terms of their effects on Product Categories, individual Products, Business Activities etc. Evidence of the application's effectiveness here is that it "provides a universal panoramic view of all relevant impacts to product or company operations" (Compliance Officer). This helps identify compliance *Issues* for management and decision making. The application also supports users so that they can collaboratively evaluate, escalate, and address compliance *Issues* using a well-designed, integrated Web interface: for example, compliance officers or managers can quickly delegate to, or monitor *Issues* with, those (e.g. product design/manufacture engineers) with responsibilities for those issues. The application can also help users to generate *Action Plans*, so they can monitor and manage *Tasks* associated in dealing with *Issues*: the *Watches* and *Reminders* features also help users track and manage compliance Issue-related responsibilities. Finally, a *Risk Ratings* facility helps illustrate the level and history of risk and opportunity for each *Issue*. These features help Napa raise awareness and enhance communication in order to implement compliance solutions.

C2P helps Napa manage compliance knowledge as it captures user discussion threads on *Compliance Imperatives*, *Impacts* and *Issues* as *Comments*. Furthermore, it helps users to create *Contexts* for classifying and reporting the evolving implications of *Issues*. In addition, the applications *History Links* provide an audit view of all changes and updates and any changes to a user area of responsibility triggers an *Alert*, in the form of an automatic email notification to responsible users. For example, the Compliance Executive stated that now "[c]orporate HQ can gather intelligence and data from regional employees and external experts in a structured, change controlled, one stop shop system—it also removes email overload." Members of the compliance team and product engineers also use the *Attachment* feature to link related documents for easy storage and retrieval. Finally, an enhanced *Search* feature permits users to run queries and generate reports based on specific parameters. In conclusion, the C2P application also affords users a customizable *Personal Dashboard* with the ability to generate reports based on particular *Compliance Imperatives*, *Impacts*, and *Issues* and to present a history of *Related Searches* and a *Bookmarks* feature that helps users navigate quickly to related structured data sources of knowledge.

Managers at Napa argue the company can now avoid compliance officers and R&D manufacturing engineers spending 100% of their resources on tracking policy, associated standards and regulatory measures, as opposed to maintaining delivery of higher value-add activities such as compliance assessments, addressing and managing issues, and the implementation of compliance with imperatives. For example, Napa's Compliance Executive stated that "[p]olicy and compliance specialists can maintain their attention to value-added activities—assessments, influencing, implementation" ... "C2P enables our compliance team to move away from the inordinate amount of time spent on tracking and monitoring activities and to focus on activities 2, 3, and 4 which are the bits that really add value to the company." In addition, its compliance officers and R&D engineers can now tie the actions and decisions taken at a product team level with the terms, definitions and guidance provided by legislators. Finally, the firm can now reduce time and cost associated with getting independent guidance and assessment on regulatory definitions and requirements as "ambiguous requirements, *Terms and Definitions* can be directed to independent policy/legal experts, all under one 'virtual' roof" (Compliance Executive). Thus, the C2P application was of tangible help to Napa Inc. in managing product compliance and minimizing any risk to the company by being out of compliance.

Furthermore, it was also stated that the ability of C2P to manage knowledge “eliminates intelligence/knowledge drain when an employee leaves the company.”

4 SUMMARY AND CONCLUSIONS

This paper makes several contributions to research on IS through its presentation of a case study on the design of an enterprise-level IT artefact by a small-to-medium sized software ENTERPRISE (SMSE) company, which, industry experts argue. This SMSE provides a novel solution to the problem of managing global, regulatory compliance imperatives. This study’s first contribution is that it describes a conceptual model of an IT-enabled Compliance Knowledge Management System (CKMS)—significantly, the paper reveals that the model is informed by the ‘situated practical theory’ of the practitioners participating in the study. The paper then outlines the Compliance-to-Product (C2P) application’s underlying design problems and their solutions. It was through the development of a robust design and the use of tried and tested Open Source technologies that a team of 9 software engineers developed an enterprise-level CKMS for a high-profile Fortune 500 IT company in just 9 months. The third major contribution concerned the description of several of the C2P application’s main features and functions in action at Napa Inc. Evidence of the design’s success is that C2P is being adopted by a growing number of IT manufacturing firms—including two multi-billion dollar Fortune 100 high-tech organizations.

The origins of C2P lie in its creator’s practical experience of the European regulatory environment with a leading consultancy firm. His early application of *phronesis* (practical or experiential knowledge) and *nous* (intuitive reason) helped him identify that industry-based practitioners faced significant challenges in ‘repairing the breakdowns in understanding’ caused by of the complex web of regulatory imperatives. Accordingly, he felt that an IT artefact needed to be designed to help them make sense of and understand compliance imperatives and to repair such ‘breakdowns’ (cf. Butler & Murphy 2007). While he knew ‘what’ the IT artefact should do at a conceptual level, he did not have the required *phronesis* and *techne* in software design to realize his design in practice. He had, however, the required ‘practical knowledge’ to collaborate with, and guide, software engineers in applying their design *techne* to develop the C2P application. (He also displayed nascent marketing abilities, in addition to the ability to generate funding from a range of public and private sources.) The findings illustrate that it was through a network of collaborations, which included early participation by the researchers, and Napa Inc.’s participation in the application development process (which was influential in tailoring the design to user requirements), that his conceptual design was transformed into a working software application. Hence, the emergent design, and the resultant IT artefact, were essentially ‘co-produced’ by a network of social actors—some of whom were ‘great designers—through the application of their ‘*phronesis*’ and ‘*techne*’. Thus, we argue that the findings of this study provide support for the propositions presented earlier in the paper.

It is fair to say that scientific theory (*episteme*—whether from design science or semiotics) played no significant role in the design process described above, as the application of the ‘collective’ *phronesis* and *techne* of those involved led to a robust and effective design that met, and continues to meet, the needs of business users. Given this interpretation of the design process at Compliance and Risks, is Baskerville (1999) correct in arguing that practitioners articulate ‘situated practical theory’? Or, following Gadamer (1975), are practitioners’ theories more correctly identified as ‘prejudice-laden’, ‘*phronesis*-based, ‘horizons-of-understanding’? Again, following Gadamer, if design practice is viewed as an interpretative endeavour, with the outcome being one of helping to repair users’ ‘breakdowns in practical understanding’, then *phronesis* is the mark of good design practice. It is through the application of *phronesis* that designers arrive at their interpretations and understandings of what needs to be done to solve a particular design problem. In the final analysis, therefore, is a ‘theory of software design’ possible when design in practice is the application of ‘practical knowledge’ (*phronesis*) and ‘skills-based knowledge’ (*techne*)? Certainly, design theory can inform the formulation of a ‘sound methodology’, in Fred Brooks’ parlance, in that a ‘methodology’ is, essentially, a *techne* that can enhance the ‘skills-based knowledge’ of practitioners. But, if ‘great designs come from great designers’, then ‘design science or theory’ is, surely, limited in its ability to

shape design practice. Finally, although generalizations from a single case are unacceptable from a design science perspective, this paper offers valuable insights into the manner in which small-to-medium sized software companies—which are the ‘well-springs’ of innovation in software design—build novel applications for use in business enterprises.

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