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A New Paradigm for Virtual Knowledge Sharing in Product Development based on Emergent Social Software Platforms

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Abstract

The UK Government considers its Aerospace Industry (AI) a remarkable success story, enjoying a global market share of 17% in 2015. The capture, management and sharing of employee knowledge is seen as vital if the industry is to remain highly innovative and retain its pre-eminent position internationally. Aerospace manufacturers, such as BAE Systems, often have to re-engineer business processes routinely to ensure their survival. Knowledge sharing in the industry is seen as challenging due to the dispersed nature of its operations and multi-tier supply chains. This paper, through a five-year participant-observation study at the World's second largest aerospace and defence organisation, BAE Systems, adapts emergent social software platforms such as Enterprise 2.0, termed by McAfee [1], to propose a framework applying the SLATES paradigm to collaborative knowledge sharing in dispersed aerospace product development. The proposed framework is applied to the bespoke BAE Systems' engineering lifecycle process to validate its effectiveness with results indicating that Enterprise 2.0 technologies offer a more openly-innovative environment in which employees may share and receive knowledge more easily across geographical and functional boundaries.

Keywords

Aerospace Manufacturing, Dispersed Product Development, Enterprise 2.0, Innovation and Knowledge Management, Knowledge Sharing, Virtual Teams.

Introduction

The 21st Century has been identified as a time of rapid innovation and technological advancement, with the last two decades being characterised by major developments in enterprise globalisation and technological advancement, particularly highlighted by the birth of the World Wide Web (WWW) and the introduction of Web 2.0 technologies such as micro-blogging (e.g. Twitter.com), social networking (e.g. Facebook.com) and web conferencing facilities (e.g. Skype). Building upon the underlying characteristics of Web 2.0 (e.g. user-generated and participant centred), Enterprise 2.0 refers to Web-based collaborative technologies which companies may employ to allow them to make the pre-existing knowledge and skills of workers more widely visible and shareable around the organisation. When used judiciously, Enterprise 2.0 can facilitate the dismantling of organisational hierarchies and silos and allow for improved knowledge sharing between employees [2, 3]. The term was first coined in 2006 by Professor Andrew McAfee [1] of Harvard Business School who defined it as "the use of emergent social software platforms within companies, or between companies and their partners or customers". He stated that Enterprise 2.0 technologies should comprise six key functional elements, which he referred to under the acronym SLATES (Search, Links, Authoring, Tags, Extensions, Signals), as shown and described in Table 1.

Table 1: Six Key Components of Enterprise 2.0 (SLATES)

<<< INSERT TABLE 1 ABOUT HERE >>>

The increased development and usage of such technologies in a business context has resulted in many opportunities being created for manufacturers worldwide, especially in the aerospace sector where it is often difficult to identify and locate individuals who possess highly specific expertise. Many manufacturers already appreciate the benefits of being more social in their work practices, acknowledging that Enterprise 2.0 allows for greater productivity, the generation of collective intelligence and collaborative innovation. By deploying Enterprise 2.0 technologies during Product Development (PD) projects, manufacturers are able to connect people to people and people to information; facilitate connectivity, sharing and collaboration across boundaries; capture a wide base of typically informal or highly dispersed views and information; help colleagues identify and locate previously unknown experts; and help employees discover organisational knowledge [4]. However, with opportunities, comes numerous problems and challenges related to their openness in communication and lack of hierarchical control across geographical and functional boundaries. In an increasingly international marketplace, manufacturers need to develop flexible and responsive work practices to ensure their survival [5], while also introducing new systems and processes for: successful innovation; the facilitation of enhanced employee and supplier collaboration across multi-tier supply chains; and the provision of opportunities for the development of employee skills and knowledge. A manufacturer's ability to create new products and innovative enhancements to existing ranges is seen as one of the strongest driving forces responsible for the sustained sales of manufactured products.

The ever-changing needs of customers are now driving manufacturers to introduce new products to their portfolio of offerings more frequently in order to sustain business, improve annual turnover and ultimately continue to exist. In order to introduce new products to the marketplace, manufacturers have incorporated New Product Development (NPD) processes into their operational strategy, aimed at developing new concepts more effectively and efficiently [6]. The NPD process is accomplished by following various phases of project definition-based tasks that primarily examine the right business

opportunities and product concepts to meet potential or existing customer requirements. At the heart of this process is the product conceptualisation phase, which is facing numerous challenges that have emanated due to the dramatic increase of data gathering and interpretation necessary to meet customer needs [7]. In addition, ongoing concept development programmes need to respond to changes in the market place far quicker, creating a need for improved design insights during conceptualisation and a requirement for deeper processing of available data from end-users in order to capture real-time information of their changing needs and feedback, based on their interactions with existing products [8].

Nowadays, it is no longer sufficient for internal departments to simply work in cross-functional teams sharing ideas captured from the lessons learnt and experience of previous projects. Manufactures must now engage in real-time conversation with the stakeholders of the PD process, including end-users and supply chain partners, utilizing current Web 2.0 technologies to communicate and identify recommended changes and enhancements to existing ranges. It is important for the success of any product development programme that stakeholder data and other business requirements are incorporated into its early stages [9]; Figure 1 illustrates the information capturing process of the three main requirements needed at the early stages of new product development; these include 1) Data gathering, 2) Data and analysis and 3) Data appropriation, which form the process of capturing the front end of requirements in a product development programme [10].

<<< INSERT FIGURE 1 ABOUT HERE >>>

Fig.1. Product Conceptualisation Process

As manufacturers aim to develop improved solutions in less time with reduced costs, the traditional PD process has become no longer sufficient. Successful PD relies far more upon greater corporate teamwork, with the 'team' being located internally and externally, often in dispersed locations

and in different time zones. Such is the case with Boeing Corporation and its 787 aircraft, which is designed and manufactured across four continents, with 14 independent original equipment manufacturers. In order to maintain and develop competitive positions, successful knowledge sharing during PD and the ability to innovate and introduce new product platforms and innovative enhancements to existing ranges are fundamental to success [11]. It is no longer sufficient to re-engineer product and service offerings; if companies wish to survive and prosper, they have to explore, exploit and retain their employee and corporate knowledge in order to sustain competitive advantage [12].

Especially in relation to engineering and high technology sectors, such as the aerospace industry, the effective management and sharing of knowledge is paramount [13]. Failure to achieve this can ultimately restrict access to key information, fail to address product defects and reduce opportunities for innovation. In the AI, design and manufacturing engineers are no longer simply required to have the knowledge to fabricate products, such as civilian airplanes and combat aircrafts; they now have to develop their knowledge and skills to be proficient in the use of Computer Aided Design/ Manufacturing/ Engineering (CAD, CAM, CAE), Product Data Management (PDM) and Product Lifecycle Management (PLM) software and other knowledge-based systems [14]. Research [15] has shown that engineers in PD teams are increasingly expected to work collaboratively across geographical boundaries and between multi-functional business units and multi-tier supply chains. In the case of the collaborating company, BAE Systems, the need for enhanced collaborative knowledge sharing is viewed as imperative. The company works with over 1250 independent suppliers in the UK alone, with 20,000 worldwide; on average, £10 billion is spent per annum on supplier integration. Additionally, with the advent of lean and agile manufacturing processes, the scope of PD has been extended to incorporate both client base and supply chain. The process now frequently involves multi-disciplinary groups including designers, engineers, manufacturing/technical specialists, customer representatives, supplier partners and third-party consultants, as illustrated in Figure 2.

<<< INSERT FIGURE 2 ABOUT HERE >>>

Fig.2. Multi-Tier Aerospace Supply Chain

Knowledge Sharing via Web 2.0 in Aerospace Manufacturing

In large, globally-dispersed aerospace manufacturers, such as BAE Systems, research has shown that creating a sustainable knowledge sharing culture is a highly complex task [16]; the working together of colleagues can never be guaranteed and companies must strive to facilitate team working to develop true competitive advantage. In dispersed organisations, employees often cannot identify what is known by other colleagues as it remains hidden in knowledge silos; consequently, best practices, expertise and knowledge and skills cannot easily be transferred. However, Web 2.0 technologies offer the prospect of transferring tacit as well as explicit knowledge in an easier and less-formalised method.

It is widely recognised [14, 16] that effective knowledge sharing is a key component of successful PD in the AI. In dispersed manufacturing teams, the capture and sharing of knowledge can offer many benefits, among which integrated PD is seen as key to enterprise process management. The integration of people, processes, information and knowledge through technology is fundamental to effective enterprise knowledge sharing [17]. Over the years, ICT systems have contributed to an explosion in the availability of knowledge stored within codified files. Now, however, research shows [18] that engineers no longer wish, nor indeed have the time, to read through entire computer-based documentation; instead, they wish to acquire knowledge selectively from a variety of sources and media types, including Web 2.0 technologies which may embed video, imagery and other media types. PD teams must, therefore, optimise the capture and use of design ideas and concepts, while collaborative Web 2.0 technologies currently being employed and developed can greatly assist this. Furthermore, the geographical dispersement of global virtual

development teams frequently found in multi-national manufacturers demand the greater use of web 2.0-based collaborative technologies.

Collaboration during PD often requires dispersed colleagues to communicate and work together to deliver innovative products and services. A distinguishing feature of a collaborative production environment is that the design and manufacturing functions, although dispersed, are often networked, well-integrated and work together effectively; in this regard, the WWW is fundamental. With the rapid growth in the use and popularity of Web 2.0-based technologies, knowledge exchange around the world has become easier and more common, with team members being able to work collaboratively and often simultaneously. To this end, it is proposed that knowledge originating from multiple sources may be effectively integrated within the PD process using designated knowledge management systems employing Web 2.0-based technologies.

Aim and Method

Against a background where aerospace manufacturers seek to enhance methods of knowledge sharing to meet PD targets while developing competitive advantage, it is believed that Web 2.0 technologies provide the means to contribute to such improvements. The aim of this research is to extend and adapt the research of McAfee [1] by applying the SLATES paradigm to the bespoke Engineering Lifecycle Framework (ELF) employed at BAE Systems' Electronic Systems. An Enterprise 2.0 framework, which formed the basis for the development of a previously reported Enterprise 2.0 groupware [19, 20], is presented.

The authors adopt a participant-observation approach to this research. From 2010-2013, the first author of this paper was employed as a PhD Researcher at BAE Systems' Electronic Systems division in Rochester, Kent, UK. From 2013-2015, he was employed as a Research Fellow working collaboratively with BAE Systems. During both of these periods, his supervision team consisted Professor James Gao

from the University of Greenwich and Nick Martin (Innovation and Growth Leader) and Clive Simmonds (Chief Engineer of Operations) of BAE Systems. Over the 5 year period, the first author acted as a participant-observer inside the company, learning the complex nature of the company's bespoke PD process by observing with "an ethnographic sensibility" [21]. On a monthly basis, the first author would hold a two hour long meeting with his supervision team to discuss collaboration and knowledge management issues experienced by his colleagues inside the company. On a bi-yearly basis, the authors would present their findings to senior management of the Rochester site to formulate ideas and scope the development of the proposed framework and developed collaborative groupware.

By immersing himself in the NPD facility, the first author was able to collect a vast amount of data over the five year period through various methods, including observation, focus group and online survey. Results of several studies [4, 19, 22] inspired the development of the proposed framework from which a collaborative groupware was developed and validated [3].

An Enterprise 2.0 Framework for Virtual Employee Knowledge Sharing

The proposed Enterprise 2.0 Framework for improving employee knowledge sharing during the PD process is inspired by and seeks to build upon the work of McAfee [1]. While recognising that digital platforms, under the name of 'Web 2.0', were already popular on the WWW for generating, sharing and refining information, McAfee coined the term 'Enterprise 2.0' to provide a clear focus on the use of "emergent social software platforms" within companies. To this end, he highlighted that "platforms are digital environments in which contributions and interactions are globally visible and persistent over time" and emphasized that "emergent means that the software is freeform in so far as it means the software is most or all of the following: 1) Optional, 2) Free of up-front workflow, 3) Egalitarian, or indifferent to formal organisational identities, and 4) Accepting of many types of data, and as such, contains

mechanisms to let the patterns and structure inherent in peoples interactions become visible over time" [23]. He provided a specific focus on something which could, in his opinion, be seen as strange technologies and technology-communities by many people; these included: blogs, Facebook, Wikipedia, Twitter, wikis, social networking software and others, including prediction markets and so on. In other words, he provided a spotlight onto the opportunities on offer to organisations to make visible the practices and outputs of their internal and external knowledge workers.

McAfee identified six key functional elements of Enterprise 2.0 and these consisted of Search, Links, Authoring, Tags, Extensions and Signals, otherwise known as SLATES, as presented in Table 1. At the heart of the framework proposed in this paper lie examples of the types of Web 2.0 technologies currently in common usage within BAE Systems. Surrounding these are the key elements identified by McAfee (SLATES) which form the inner focus of the framework; these emphasize the central role that Web 2.0 technologies are capable of playing during business processes and, in particular, during PD. In the proposed framework presented in Figure 3, SLATES are presented against a background where Customers, Suppliers, Employees and Other Stakeholders are able to input to the PD process through the use of Web 2.0 tools which facilitate the creation of user-contributed content.

<<< INSERT FIGURE 3 ABOUT HERE >>>

Fig.3. Proposed Enterprise 2.0 Framework for Improving Virtual Employee Knowledge Sharing during PD

At this point, it is important to emphasize that Web 2.0 technologies are often selected and used arbitrarily by knowledge workers and are capable of facilitating collaborative PD processes in a less formal manner; significantly, they act as enablers of the key actions of Communicating, Reviewing, Investigating, Improving, Evaluating, Refining and Sharing – CRIIERS Actions – which are required

during the seven stages of the generic PD lifecycle, as proposed by Cooper and Kleinschmidt [24]. In other words, enhanced generation, sharing and refinement of knowledge in business is made achievable through the use of Web 2.0 as the tools provide the functionality of the six key SLATES components of Enterprise 2.0 and facilitate the key CRIIERS actions necessary for effective new product development.

It is self-evident that PD should remain an iterative process and collaborators are continually empowered by Web 2.0 to communicate and review ideas and opinions, develop concepts, analyse data, review and improve colleagues' contributions and provide direction to proposed development ideas in a relatively informal social environment [3]. Furthermore, both external and internal stakeholders are able to participate in collaborative processes with comparative ease, while knowledge may be shared and managed in a virtual global environment relatively unhindered by traditional perceived barriers, such as geography, cost, time and even animosity between individuals who may not interact well in face to face situations.

Enterprise 2.0 as a concept offers organisations the prospect of more powerful outcomes as individuals can use personal online practices to enhance commercial knowledge development without the typical constraints found in more traditional business environments. Global virtual teams may be encouraged to participate in PD processes in Enterprise 2.0 online communities with enhanced sharing of user-generated content being the outcome to the benefit of all. The interaction of all of the elements described in the framework allows for the generation of more creative and innovative solutions in a farther-reaching informal environment.

When considering the use of the proposed Enterprise 2.0 framework within organisations, it is important to remember that this is a generic framework which is adaptable to bespoke PD processes. Furthermore, it should be noted that the framework describes a process or method of working which is different from more traditional practices – it still anticipates making use of the same initial information sources available within global teams and enterprises but, significantly the process is facilitated in a very

different manner. The potential on offer, as outlined by the framework, is for enhanced knowledge generation as a result of collaborators being empowered and encouraged to generate and share more of their own content in the less formal, but potentially more powerful and creative, environment of Enterprise 2.0.

The Proposed Framework in Practice

The central portion of the framework in Fig. 2 illustrates some of the key Web 2.0 technologies on offer to collaborators during the PD process. Through appropriate selection from the range of technologies and tools depicted in the central SLATES core, users are able to access the key components of SLATES and benefit from their functionality and capabilities. The functionality provided by Web 2.0 also allows collaborative workers to perform the key CRIIERS actions which are identified beyond the central core. Fundamentally, Web 2.0 allows users to:

- **Communicate** readily with an accessible record of data communicated;
- **Review** enterprise capabilities and data within a collaborative environment;
- **Investigate** concepts, opportunities and fresh input;
- **Improve** products and designs through the sharing and contribution of new information, knowledge, comments and ideas;
- **Evaluate** facts, figures and proposals prior to embarking upon further actions;
- **Refine** ideas, concepts and theories; and
- **Share** comments, thoughts and feedback more easily and informally.

Key objectives for those involved in PD are to generate and screen ideas; develop and test concepts; analyse businesses and markets; implement technical innovations and commercialise products through continuing constructive collaboration. It is against this background where the fundamental roles performed through CRIIERS actions, and facilitated by Web 2.0 tools, may be visualized; quite simply, they allow collaborators to communicate and review data and ideas, investigate and improve testing and analysis of concepts, evaluate opportunities, refine plans and share information, knowledge and skills more comprehensively. When attention is turned towards the generic product development process, which has seven commonly recognised steps and is denoted in the framework by the outer ring with arrows, it may be observed that the CRIIERS actions provide the essential linkage between Web 2.0 and PD activities and highlight the ability of Enterprise 2.0 to enhance the process. Finally, the outer circle demonstrates the globally-inclusive nature of Enterprise 2.0, which enable both internal and external stakeholders to be fully involved in the PD process.

In summary, the proposed Enterprise 2.0 Framework illustrates a new paradigm for operating in a virtual environment where the same information and ideas available at the start of traditional PD processes may be used differently to deliver more powerful outcomes; these result from the greater freedom offered in Enterprise 2.0 communities for collaborators to be more creative and spontaneous in the generation and sharing of new knowledge.

Application of the Proposed Framework to BAE Systems

Product development projects at BAE Systems follow a bespoke product lifecycle process called the Engineering Lifecycle Framework (ELF); this identifies a series of 5 stages with 13 separate maturity phases (Figure 4) that a product may go through during its lifecycle. Each maturity phase is seen as a key milestone or gateway through which the development activity must pass during the lifecycle of a product.

There are clear expectations established for the transition of one phase to another and a pre-agreed range of deliverables have to be satisfied; such actions aim to guarantee a high level of consistency and quality in the development process. Essentially, the BAE Systems development process is a customised and extended version of the generic PD lifecycle. Not all phases are mandatory, although they are fundamental to the process, and the criteria for passing from one phase to another should be documented, with deliverables representing the input criteria for the subsequent phase.

<<< INSERT FIGURE 4 ABOUT HERE >>>

Fig.4. Engineering Lifecycle Framework for a Product at BAE Systems (Courtesy of BAE Systems)

By substituting the 13 separate phases of the BAE Systems' ELF process for the generic PD process shown in Figure 5 and amending the framework accordingly, it is possible to demonstrate that all BAE Systems' potential ELF actions are again capable of facilitation through Web 2.0 technologies, which perform the key CRIIERS actions identified.

<<< INSERT FIGURE 5 ABOUT HERE >>>

Fig.5. Enterprise 2.0 Framework applied to the BAE Systems PD Process

When considering the process in detail, it is possible to identify a comprehensive series of actions specified in the BAE Systems ELF and compare them with the key CRIIERS actions (Table 2). From this table, it can be concluded that all BAE Systems potential ELF actions are deliverable via the CRIIERS actions facilitated through Web 2.0 and this is consistent with the generic Enterprise 2.0 Framework. Consequently, it may be surmised that the generic Enterprise 2.0 framework is readily transferrable to organisations employing bespoke PD processes developed from the generic model. It is

apparent that the key actions of Communicate and Share are required elements throughout the BAE Systems PD process and other CRIIERS actions play key roles on a routine basis throughout the process. Accordingly, it may be deduced that the Enterprise 2.0 framework is applicable to the BAE Systems product development process.

Such a conclusion is also reinforced by a detailed comparison of the CRIIERS actions against the BAE Systems' product maturity gateways, as may be observed in Table 2. During each Maturity Phase, there is abundant evidence of CRIIERS actions being performed by PD team members and Web 2.0 technologies are seen to be clearly capable of playing key roles during these interactions.

Table 2: Comparison of CRIIERS Actions with BAE Systems' Product Maturity Gateways

<<< INSERT TABLE 2 ABOUT HERE >>>

Based upon the findings of research conducted during the participant observation [4], which involved in-depth face-to-face interviews with 67 senior members of engineering and management staff within BAE Systems, it has proven possible to identify a set of recommended guidelines to inform those organisations which plan to introduce Web 2.0 technologies into their NPD activities. The guidelines, as shown in Table 3, have been produced following extensive analysis of staff opinions and views; this allowed a comprehensive understanding to be gained of the typical tasks and communication methods that manufacturing engineers within the collaborating company employ when working on NPD projects. The authors then studied the characteristics of the more popular Web 2.0 technologies available today and considered their relationship to the common tasks undertaken during the product development process; this allowed the characteristics and functionality of each technology to be correlated with the PD tasks in order to formulate the proposed guidelines. Finally, after further evaluation and review with the supervision team to confirm which technologies were relevant to the needs of the organisation, the

guidelines were presented to and discussed with senior key stakeholders at bi-yearly meetings to confirm their applicability and suitability for the improvement of enterprise product development practices.

Table 3: Recommended Guidelines for improving Collaboration and Knowledge Sharing during the Product Development Process using Web 2.0 Technologies

<<< INSERT TABLE 3 ABOUT HERE >>>

Given the nature of contemporary Web 2.0-based tools, which are continually evolving and being developed, it is not asserted that the guidelines are not exhaustive in scope. However, it is believed that they provide an informed overview of the more common Web 2.0 technologies which may be employed to best effect to enhance collaborative and knowledge sharing practices within enterprises seeking to optimise their PD activities. By adopting the foregoing suggestions, organisations may improve their practices and, consequently, create more value added designs and product/service offerings to satisfy ever-increasing commercial demands, ultimately resulting in competitive advantage.

Conclusion and Future Work

Building on the author's prior work, an Enterprise 2.0 framework has been developed to propose a concept of a new paradigm for collaboration and knowledge sharing during the engineering product development process through the utilisation of emergent social software platforms including Web 2.0 technologies, which have been widely used for social communications and connectivity at explosive growing pace. The framework was inspired by the work of McAfee [1] and identifies seven key CRIIERS actions which provide linkage between interactive Web 2.0 technologies and traditional and bespoke product development processes. The new framework was applied and tested by a world leading aerospace

company BAE Systems for its new product development process and guidelines have been provided to the users of the dispersed teams involved in product development.

Further research should be completed into the motivational factors which encourage engineers to interact with Web 2.0 technologies. It was identified that employees do not always interact readily with Web 2.0 (McAfee, 2006b) and it would, therefore, be of value to profile the psychological factors which encourage or discourage the use of Web 2.0 in manufacturing facilities; to this end, the question of gamification or endorsement of the contribution of others could also warrant a further separate study. Another recommendation for further research is to explore and understand the extent to which Enterprise 2.0 technologies actually improve the performance and output of engineering and manufacturing project teams in a quantifiable manner. Key Performance Indicators could be established for such work and these could be measured when Web 2.0 technologies are employed and when they are not; an example of such a KPI could be 'time taken for colleagues to respond collaboratively via groupware compared to when e-mails or other traditional methods are employed'.

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Search	"Discoverability of information and knowledge"
Links	"Build and share links to content"
Authoring	"Generate content – contribute own knowledge, ideas and experiences"
Tags	"Upload and annotate content with own keywords and share"
Extensions	"Intelligent knowledge-based systems match preferences to users"
Signals	"Make others aware when new content is uploaded"

Product Maturity Phase	Typical Product Development Activities	Key CRIIERS Actions Involved
0	• Assess and prioritise new and emerging technologies, service trends and opportunities; • Decide if there is an opportunity that is a strategic fit to the Business and Product portfolio that justifies the resources to investigate further.	Communicate Review Investigate Evaluate Share
1A	• Increase understanding of opportunity and plan to close gaps in understanding; • Create conceptual solutions to address evolving requirements and devise strategy for solution maturation; determine: comparative cost, expected level of compliance, technology/service maturity, development schedule, and risk; • Undertake early dialogue with key suppliers; • Mature conceptual solutions and requirements to maximise degree of technical compliance or service outcome.	Communicate Investigate Improve Evaluate Share
1B	• Determine criteria for selection of preferred solution; • Assess each conceptual option against criteria and rationalise solutions down to a small number, forming new hybrid solutions where necessary; • Document reasons for solution retention and rejection; • Continue to mature requirements set, solution definition and development strategy.	Communicate Evaluate Review Share
2A	• Determine and record the preferred solution to be matured following agreed development strategy and confirming compliance with Customer requirements and the viability of the preferred solution; • Mature the preferred solution and development strategy to the point at which the risk is at a level acceptable to the Business.	Communicate Evaluate Share
2B	• Progress the maturation of the solution or understanding where the solution can be improved or was deficient to align with the expectations of the stakeholders/Customer.	Communicate Improve Evaluate Share
2C	• Confirm the maturity of the technologies and capabilities required to realise the preferred solution. • Release requirement specifications for the development of critical Product components and capabilities.	Communicate Evaluate Share
3A	• Confirm that Product design has progressed to the point that specifications can be released for the on-going development of all components/capabilities of the Product; • Support design maturity with models of the Product to be developed; • Complete the plan for testing and qualification of the Product.	Communicate Review Evaluate Share Refine
3B	• Complete the definition of the Product such that it is sufficiently mature to progress to transition and implementation; • Ensure the harmonisation of all aspects and all components of the Product design and that the expected degree of Product and sub-Product/capability compliance has been achieved.	Communicate Review Evaluate Share
4	• Build, integrate and test or transition the Product to the point of maturity that enables qualification testing to commence; • Accept for integration qualified components/capabilities of the Product supplied under sub-Contract.	Communicate Investigate Improve Refine Share
5	• Undertake qualification to ensure that the Product meets requirements and is ready for full-scale implementation and roll-out (goods) or deployment (services); • Compile compliance evidence to present as proof that the Product meets requirements; • Assess and document the impact of any non-compliance.	Communicate Investigate Evaluate Share
6	• Implement manufacturing strategy and full-scale Production (goods) or	Communicate

	deploy the service infrastructure (service); • Deliver Product and support user acceptance and handover (goods) or begin initial service delivery (services); • Implement strategy for through-life maintenance and support aspects of the Product.	Share
7	• Address the on-going provision, performance and support of the Product; • Assess the performance of the deployed Product and the effects on the Product of a changing environment to identify opportunities for enhancements or major upgrades; • Determine Product maturity as a function of deployed effectiveness.	Communicate Review Investigate Evaluate Share
8	• Review plans in preparation for withdrawal of the Product, novation of the service and disposal of physical assets; • Withdraw or terminate the support of the Product or novate the service to new service or provider; • Address the internal and external implications of closure.	Communicate Review Improve Evaluate Share

Technology	Use to…	Example Software / SaaS Providers
Blogs	• Inform colleagues and teams of current actions and future objectives; • Summarise status of projects following review meetings; • Disseminate information, knowledge and expertise; • Evaluate and review product ideas and designs; • Share results, opinions and views within teams; • Maintain informal contact with external partners; • Obtain customer feedback relating to product designs and ideas; • Encourage team feedback and comments.	WordPress Blogger LiveJournal PivotX LifeType
Wikis	• Create, organise and collaborate on PD documents, including guides and instructions; • Manage version control; • Brainstorm ideas within one document; • Provide up to date work instructions for assembly teams; • Record project updates, which are accessible by all team members; • Collect and store information and knowledge from employees.	Atlassian Confluence MediaWiki BusinessWiki wikispaces PBwiki
Forums	• Brainstorm ideas; • Facilitate discussions outside formal settings; • Submit agenda items before meetings; • Obtain feedback on product ideas and designs; • Communicate with colleagues outside formal gatherings; • Foster stronger communities in the workplace, minimising barriers and silos; • Reduce the need for presence on site.	phpBB vBulletin MyBB Vanilla Forums NodeBB
Internet Surveys and Polls	• Obtain qualitative feedback in a structured and controlled format; • Record documented opinions on project progress; • Gather and analyse quantitative data; • Determine customer interest in and opinions of new product and service ideas; • Encourage anonymous input, which may otherwise may not have been made available; • Measure employee morale during PD projects; • Gather market intelligence, including trends, data and public perceptions.	SurveyMonkey SmartSurvey KwikSurveys Snap Surveys PollDaddy
Multimedia Sharing	• Record in real-time PD tests and lessons learned (video); • Share key stages of the PD process (audio, images and videos); • Share team moments to highlight collaborative working practices (images and video); • Create online immersive experiences for potential customers; • Recognise individual and team achievement by embedding multimedia on other Web 2.0 tools; • Create visual work instructions for project team members.	Youtube Vimeo Flickr Picasa Ustream
File Sharing	• Upload files and document folders for access by colleagues; • Access PD documents when away from the office; • Manage version control within PD teams; • Access PD documentation via portable devices; • Share PD documentation with other stakeholders.	DropBox yousendit nomadesk Egnyte ShareFile
Micro-Blogging	• Inform others of what you are doing and encourage comments, questions and sharing via re-posts; • Communicate and give feedback quickly to colleagues by posting short personalised messages to their news feeds; • Inform team members of your current schedule and availability;	Yammer Twitter FriendFeed Tumblr SocialText Signals

	• Direct colleagues to informative content on the intranet or internet by re-posting; • Provide status updates on product tasks and failures; • Communicate with potential customers and suppliers; • Provide a 'live support' for PD team members; • Gauge customer feedback and build product awareness.	
Social Networking Sites	• Facilitate informal communication and collaboration within defined groups and teams; • Create an open interactive working culture with reduced management barriers; • Recognise and reward good work by adding "likes" and "personal comments" on individuals' profiles, which are visible to colleagues and peers; • Share information and content easily with colleagues; • Mentor individual groups and teams through the posting of constructive advice.	Facebook LinkedIn Google+ Youtube FourSquare
RSS Feeds	• Monitor news and information from multiple sources, including employee blogs, corporate headlines etc.; • Keep abreast of employees' social networking posts and comments through one channel; • Control the amount and flow of information to your computer; • Monitor social media activity streams to be aware of employee views.	NewzCrawler FeedDemon Google Reader NewsGator Omea Reader
Slide Hosting	• Share presentations with colleagues and dispersed teams; • Store and access presentations when away from office; • Display presentations when hosting online meetings; • Embed presentations in blogs and other Web 2.0 services; • Locate presentations uploaded to other sites by colleagues.	SlideShare Sliderocket SlidePub SlideServe SlideBoom
VOIP and Video Calling	• Conduct face-to-face discussions in real-time; • Minimise cost of voice communication within dispersed teams; • Deliver training and tutorials to non-co-located colleagues; • Hold discussions with contemporaneous access to other means of information transfer; • Receive voice mail messages to your e-mail when unavailable.	Skype WebEx Adobe Connect Google+ Hangouts Vonage