Preface

INTRODUCTION

This is the fourth sequel of volumes on the series of Advances in Information Technology and Web Engineering titled: Web Engineering Applications for Evolving Organizations: Emerging Knowledge based on revised and extended articles published in Volume 4, 2009, and highlights the importance of knowledge in the new evolving organization in the next decade. In this introduction, two disciplines related to the theme of the book are explained: Software engineering and knowledge systems. In the second section, the characteristics of the knowledge-based evolving organization are explained. The latter two sections highlight recent technology platforms for Web-based applications and related latest application domains, respectively.

SCOPING THE WEB ENGINEERING DISCIPLINE

Looking back at the articles published in the first four volumes, perhaps it is time to go back and reflect on the scope of software engineering before we start highlighting issues related to the theme of this volume.

The field of Web Engineering has been defined in several ways. Here are two definitions: (1) The application of systematic, disciplined and quantifiable approaches to the cost-effective development and evolution of high-quality solutions in the World Wide Web. (webengineering.org), and (2) Web Engineering covers the realization of solutions within the World Wide Web, its applications and its advancement, in particular its approaches, methods, models, principles and tools, which are based on the information and communication technologies of the Internet. (iswe-ev.de)

In an article that reviewed 11 books on Web Engineering highlighted the following common themes and contents (Pröll and Reich, 2010):

- Web Engineering Process
- Formulation and Planning Analysis
- Modeling of Web Applications
- Design Modeling for Web Applications
- Testing of Web Applications
- Web Science extensions
- Semantic Web

An analysis of a Web Engineering maturity model shows the concentration on application development processes and user analysis (Deshpande, 2003).

In a keynote presentation, the author presented 8 levels of Web application types (www.icwe2004.org/speakers.html):

- **Document centric:** Static homepages, company Web sites
- **Interactive:** Virtual exhibition, news sited, and travel planning
- **Transactional:** online banking, online shopping, booking systems
- **Workflow-based:** E-government, B2B solutions, and patient workflow
- **Collaboration:** Chat room, e-learning, and virtual shared workspace
- **Portal-oriented:** community portals, online shopping mall, and business portals
- **Ubiquitous:** Customized services, location-aware services, and device independent delivery
- **Knowledge-based:** recommender system, syndication, and management information system

Clearly, previous discussions may lead readers to believe that the concentration of Web Engineering field is on Web-base application development, such as Web site design and E-business and E-government applications. However, research in the field during the past four years expounded other areas, such as Web search mechanisms, email filtering, Web-based cooperative learning, practices of open software development, agent technologies, and social networks. Therefore, researches and practitioners need to look at Web engineering field as encompassing other areas beside Web site application development. This nullifies the notion that Web engineering is purely a subset of software engineering.

The discussion on Web engineering will not be complete without mentioning two other related fields found in the literature when searching for Web engineering, namely Web science and GeoWeb. To shed some light on these two fields, a sample curriculum and conference themes are provided below.

A sample curriculum for Web science follows (wiki.websciencetrust.org/w/Curriculum_topics):

- History of the Web
  - Forerunners (Otlet, Wells, Bush, Engelbart, Nelson) - information systems, concepts, early computer systems
  - Hypertext Community - information systems
  - Internet history - DARPA, IP, TCP, FTP, WAIS, GOPHER
  - W3C History - See W3C timeline
- Building the Web
  - Web Architecture (HTTP, HTML, URI, XML, XSLT, JavaScript, AJAX)
  - Key Algorithms
  - Community Inclusion- Incentives for Innovation - Openness / universality
  - Decentralization
  - Governance
  - Standards
- The Web in Society
  - E-commerce
  - IP / copyright
  - Privacy
  - Co-evolution of society and web

- ◦ Culture and technology
- ◦ Systems theory
- ◦ Social structures and processes
- ◦ Groups and identity
- ◦ Commercial structures and economics
- ◦ Globalization
- ◦ Social capital and power inequality
- ◦ Collective intelligence
- Deploying the Web - Operational sing Web Science for a World of International Commerce
  - ◦ Business Strategy
  - ◦ Information systems (basics of)
  - ◦ Cloud computing infrastructure
  - ◦ Policy
  - ◦ Regulation and security
  - ◦ Sector-specific info
  - ◦ Online markets
  - ◦ Design vs evolution
  - ◦ International context - developed and developing world
  - ◦ Profit vs common good
  - ◦ Software / hardware context (speeds etc)
- Analyzing the Web
  - ◦ Methodologies (build around case studies)
  - ◦ Uncertainties and critical thinking
  - ◦ Graph theory
  - ◦ Power laws
  - ◦ Statistics / regression analysis
  - ◦ Networks - game theory, social network analysis, ANT
  - ◦ Web mining
- Understanding Web Users: Surveys and Qualitative

The 2011 GEOWEB conference program will focus exclusively on Smart World Applications and their value within the following industry areas (geowebconference.org/program/theme-areas): Smart Grids and Utilities, Air Traffic Management, Urban Infrastructure and, Transportation, Business and Consumer, Public Safety and Security, and Environment and Climate Change

The following figure attempts at showing the relationship among the fields of computer science (CS), software engineering (SE), Web engineering (WE), Web science (WS), and GEOWEB (GW).

The overlapping between disciplines is explained as follows:

- **Between CS and SE:** programming courses such as Java and XML
- **Between SE and WE:** Principles of SE, HTML, development environments such as Expression and Dreamweaver
- **Between WE1 and WS:** Web site development and application life cycle management for Web-based application development

Figure 1. Relationship among Computer Science (CS), Software Engineering (SE), Web Engineering (WE) (WE1: Web site development, WE2: other Web-based Applications), Web Science (WS), and GE-OWEB (GW)
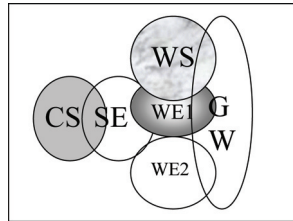
- **Between GW and WS, WE:** the methodologies and techniques employed by latter disciplines in developing applications of GW, as listed above.

KNOWLEDGE MANAGEMENT SYSTEMS (KMS) AND KNOWLEDGE-BASED SYSTEMS (KBS)

KBS is a branch of Artificial Intelligence (AI) and its corresponding application of Expert System (ES). Knowledge is represented as facts or symbols. Facts are quantifiable numbers and symbols are beliefs expressed in degrees/levels or probabilities. Knowledge could be automatically extracted from databases that stores historic facts related to a specific domain such as approving credit card applications, or manually from an expert in the domain field. Knowledge in the KMS, on the other side, is classified as tacit and explicit knowledge. KMS deals with the capturing, coding, storing, distributing, and use of structured and unstructured knowledge. Part of the KMS may be used as input to the KBS following a period of use. Therefore, we introduce the principle of validation and verification of KMS to ensure that knowledge stored in KMS continues to be valid.

Knowledge is validated during the following stages as follows: (1) Capturing: knowledge is validate against the source which could be either internal (employees of all levels) or external (suppliers and customers), (2) Coding: during this step, new knowledge is validated for proper coding for retrieval, and is checked against existing knowledge to discover any inconsistencies to be removed or explained, (3) Distribution: validation is done to ensure that knowledge is accessed at the right time, with the right format, and by the right people, (4) Knowledge verification is done at the last stage to ensure that it is used for the right decision. A feedback is requested from the user to decide whether to keep the knowledge as stored, be modified, or be removed from knowledge base.

For the purpose of building the evolving knowledge-based organization, the KMS is adapted.

Characteristics of the Knowledge-based Evolving Organization

The 11th European Conference on Knowledge Management ECKM 2010 lists the following selected sample topics for its program:

- Knowledge creation and sharing mechanisms
- Knowledge sharing between different groups in an organization

- Sharing and co-operation in Communities of Practice
- KM and innovation
- Content management systems
- Establishing Innovation networks
- KM performance criteria
- Knowledge Ontologies
- KM towards stakeholders needs
- KM and the Web and e-Business
- Km and eBusiness models
- KM sharing between individuals vs groups

In addition, The 7th International Conference on Knowledge Management, October 2010 lists the following sample topics:

- Social Networking and Online Communities
- Communication, Collaboration and Knowledge Sharing
- Knowledge Discovery
- Risk Knowledge Management

Another study suggested that utilization and processing of knowledge in the real-time enterprise is accomplished through human machine intelligence and organic sense making coupled with attention/ motivating/commitment and creativity/ innovation. In a sense, the enterprise's business environment drives the KM system through radical and discontinuous change rather than the use of information and communication technologies.

In another paper, authors cited three types of knowledge management initiatives in organization (Bold emphasis are added by author) (Alavi and Leidner, 2001)

*(1) the coding and sharing of best practices. For example, an insurance company was faced with the commoditization of its market and declining profits. The company found that applying the best decision making expertise via a new underwriting process **supported by a knowledge management system** enabled it to move into profitable niche markets and, hence, increasing income, (2) the creation of corporate knowledge directories, also referred to as the mapping of internal expertise. Because much **knowledge in an organization remains uncodified, mapping the internal expertise is a potentially useful application of knowledge management**. One survey found that 74% of respondents believed that their organization's best knowledge **was inaccessible** and 68% thought that **mistakes were reproduced several times**. Such perception of the failure to apply existing knowledge is an incentive for mapping internal expertise, and (3) the creation of knowledge networks. For example, when Chrysler reorganized from functional to platform-based organizational units, they realized quickly that unless the **suspension specialists could communicate easily with each other across platform types**, expertise would deteriorate. Chrysler formed Tech Cul, bringing **people together virtually and face-to-face** to exchange and build their collective knowledge in each of the specialty areas. In this case, the knowledge management effort was less focused on mapping expertise or benchmarking than it was on **bringing the experts together** so that important knowledge was shared and amplified. Providing online forums for communication and discussion may form knowledge networks. Buckman Laboratories uses an **online interactive forum***

*where user comments are threaded in conversational sequence and indexed by topic, author, and date. This has reportedly enabled Buckman to respond to the changing basis of competition that has evolved from merely selling products to solving customers' chemical treatment problems. In another case, Ford found that just by sharing knowledge, the **development time for cars** was reduced from 36 to 24 months, and through **knowledge sharing with dealers**, the delivery delay reduced from 50 to 15 days.*

Discussion on KM will not be complete without discussing organizational learning (OL). In his paper, the author links OL to knowledge. Organizational learning calls for continuous assessment of performance, both successes and failures. This activity ensures that learning takes place to support continuous improvement. After-action reviews and retrospects are tools that facilitate evaluation of knowledge by asking teams to discuss activities and project openly and honestly. Knowledge is a critical asset in every learning organization. Because learning is both a product of knowledge and its source, a learning organization recognizes that the two are inextricably linked and manages them accordingly. Knowledge leads to OL, and OL feedbacks to knowledge for improvements. The units of knowledge production are both individual-based and team-based. Learning organizations implies that while knowledge is created in the minds of individuals, knowledge development thrives in a rich web of social contact among individuals, groups, and organizations. A learning organization provides creative opportunities for this knowledge to be developed and shared with others through interpersonal contact and access to documentation (Serrat, 2009a).

Based on the selected reviews of previous research, the ensuing section presents several characteristics of knowledge-based organizations.

First: Ability to capture knowledge from different sources, i.e. internal and external. Employees of all levels should be given the proper and convenient venues to contribute to knowledge bases without revealing privacy information. External groups, such as customers, suppliers, and strategic partners should also have the same arrangement.

Second: Incorporate knowledge creation and capturing in all of its processes. Organizations should allow a knowledge layer to be on top of all its processes. This would include activities looking for new innovative ideas, lessoned learned, and others similar activities. This activity will provide input to the next characteristic.

Third: Effective knowledge sharing mechanisms. The following is a suggested list of areas for knowledge sharing:

- E-practices for idea management
- Best practice
- Lessons learned
- Special Interest Groups
- Expert or Expertise Directory
- Lead Tracking System for customer relationship management (CRM)
- Collaborative Systems (patents, and trademarks)
- E-Learning Systems

Fourth: Organization must learn as teams first and then as individuals by supporting triple loop organization learning through team organization structure. A model for knowledge base build up life cycle based on the three learning loops: single, double, triple is presented below as developed by the author.

Figure 2. Knowledge base build-up life cycle (KBBLC). (SLL, DLL, TLL: single, double and triple loop learning, respectively)
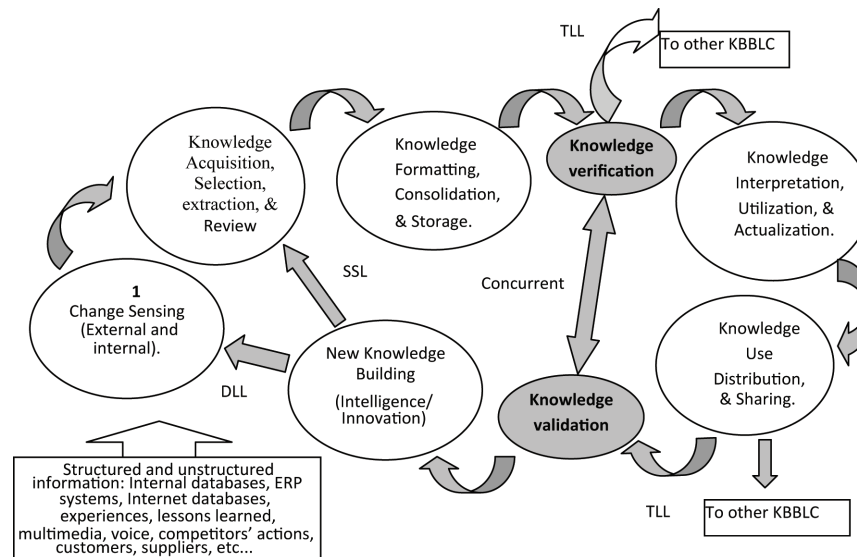
The suggested model is depicted in Figure 2.

The underlying assumptions behind this model are as follows:

- All knowledge used and created are integrated and made available; it acts as a supportive system for all activities.
- Single-Loop Learning and Double-Loop Learning are included in the model. SSL operated in functional silos, while DLL crosses boundaries of different processes belonging to one functional area or several functional areas in an organization. The Duetro Learning or Triple Loop Learning (TLL) is the link between different knowledge base build-up life cycles. The mean of implementing the latter one is through team organization, where each KBBLC is treated as a team with intra- and inter- communication is permitted to share knowledge.
- The model incorporated the steps of knowledge verification (KR) (identifying the knowledge right) and knowledge validation (KL) (adding the right knowledge) similar to the same concepts used in software engineering and as stated in the above discussion.

The steps of the KBBLC are explained in the following paragraphs. The objective in the first step, Change Sensing (externally and internally), is to obtain continuous input and feedback from external and internal environments, and have a continuous flow of new ideas, learning from organization's experience and from the experiences of best practices of other organizations. This step will provide durability and sustainability of organization's KMS. It will help the organization to become flexible enough not only to respond, but also to anticipate internal and external changes competitively. The second step, Knowledge Acquisition, Selection and Review, makes scanning of all available knowledge to decide on what to preserve for the next step. The media for the third step, Knowledge Formatting, Consolidation, and Storage, is proposed to be a hybrid model of the different tools currently used to preserve knowledge: that is a multimedia of computer-based approach and human-centered approach. The basic problem with

the first one is the content-rich, context-poor of stored knowledge. In human-centered approach, knowledge is volatile and its storage is linked to the wills of those people involved. A mix between people and technology is seen to be the right solution. The next step, knowledge verification, will check knowledge against the source, collection medium, and congruence with existing knowledge.

Step 5, Knowledge Distribution, Transfer, and Sharing, ensures that knowledge is available when needed. It can be viewed as Just-In-Time Knowledge Delivery. It is accomplished through an integrated knowledge network through computer-based solution linked with hypermedia technology and made available over the Web, and enhanced with networks of people. The sixth step, Knowledge Interpretation, Utilization and Actualization, is to digest and draw the correct conclusions from available knowledge. The next step is knowledge validation, which ensures the proper application of knowledge to guarantee continuous storage of ideas to the knowledge base. The last step, New Knowledge Building / Intelligence/ Innovation, involves the creation of new innovative ideas from existing knowledge bases through its intelligent use in organizations. The objective of this step can not be effectively accomplished unless all previous steps are correctly implemented and executed. A note on the link between knowledge verification and validation: they should be done almost concurrently. A big lead of time between the two may result in knowledge decay and irrelevancy to new and dynamically evolving environment.

Fifth: Facilitate creative thinking processes for knowledge and innovation idea generation. This could be based on current knowledge bases or stemming from the dynamics of internal and external environments. One author explains the relationship between creativity and innovation.

One article defines the relationship between creativity and innovation "creativity is the mental and social process—fuelled by conscious or unconscious insight—of generating ideas, concepts, and associations. Innovation is the successful exploitation of new ideas: it is a profitable outcome of the creative process, which involves generating and applying in a specific context products, services, procedures, and processes that are desirable and viable. Naturally, people who create and people who innovate can have different attributes and perspectives. It follows, then, that innovation begins with creativity." (Serrat, 2009b)

A suggested method is for organizations to adapt creative thinking processes and personal/team profiles. The latter one could be based on measure such as Myers Briggs Type Indicator (MBTI) (myersbrings.org) or Herrmann Brain Dominance Instrument (HBDI.com). By reviewing both sites, the author believes that the latter one is more suited to creativity thinking and team communication. In this part, the author presents an approach to integrate creative thinking process and HBDI.

Creative thinking steps include: interest, preparation, incubation, illumination, verification, application, validation, and storage. The definitions of the four brain quadrants as used by HBDI are as follow: quadrant A (QA): Logical, factual, rational, critical, analytical, quantitative, authoritarian, and mathematical, quadrant B (QB): Technical reader, data collector, conservative, controlled, sequential, articulate, dominant, and detailed, quadrant C (QC): Musical, spiritual, symbolic, talkative, emotional, intuitive, (regarding people), and reader (personal), and quadrant D (QD): Intuitive (regarding solutions), simultaneous, imaginative, synthesizer, holistic, artistic, and spatial. Measure of HBDI may be applied to individuals, teams, and organizations. Any of these three measurements, individually or collectively, may show strength in one or more of these quadrants. Strength of measure is low, intermediate, strong, and very strong, ranked from the middle of the circle outwards. Each individual, team, or/and organization has a profile that depicts the strength in one or more of these quadrants: higher measures are the ones away from the center of the circle. The figure below depicts an explanation of the four quadrants of the brain and a sample team profiles. The little circles inside depicts team member's profiles.

Figure 3. (a) The four quadrant explained, and (b) Team with balance profiles on the left and team with strong profiles in QA and QB on the right

(a)   (b)
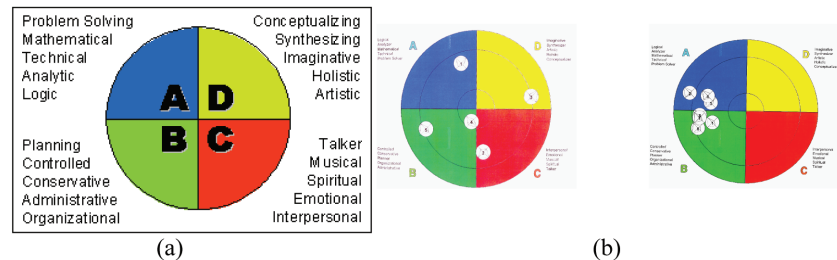
The paper again added the verification and validation steps as used in software engineering: verification will ensure that the correct procedure is followed in the adaptation of new knowledge, while validation will ensure that new knowledge do achieve intended outcomes and provide the justification to continue the use of such new knowledge. In each of the creative thinking steps, specific type of people who are strong in one or more of these quadrants is required. To start with, all four types of quadrants are required for interest and preparation steps. For incubation and illumination, however, people strong in QD and QC are required to carry on the task of adopting new ideas. People who are strong in QC are needed to convince people who are strong in AQ and QB, who normally will object to change unless they are gently brought into the wagon, perhaps through information meeting at lunch or sports activity. Individuals who are extremely strong in one quadrant should not be put at top management or as team leaders, since such HBDI characteristic would hamper progress towards adapting new knowledge. The paper suggests that the team leader should be alternated according to the step involved in creative thinking: steps 1 and 2 for QA and QB, steps 3 and 4 for QC and QD, steps 5 for QA and QB, step 6 for QB and QA, step 7 QA and QD, step 8 for QB. Figure 4 shows the steps of creative thinking and the relationship to the four quadrants.

In one reported case, for example, a software development team consisted of member profiles that are mainly strong in QA and QB and weak in QC and QD, while the team leader had a strong QD. Team members were waiting for instructions from the team leader, while the team leader was expecting members to perform independently. The team was dissolved and the project failed. Therefore, HBDI and creative thinking should assist in building effective communication channels among the following groups:

Figure 4. Steps in creative thinking and role of the four quadrants for each step (appearing letter in quadrants indicates importance)
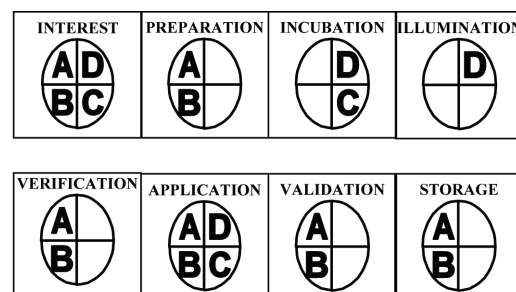
team members, team members and team leader, and inter-teams. In addition, it will create an atmosphere conducive to creative thinking processes.

NEW APPLICATION DOMAINS

In this section, three application areas are explained: virtual teams, data analytics (Business Intelligence), and Web content management.

Virtual Teams

Virtual Communities (VC) may consist of organizations, teams, and social groups. A VC indicates an organizational or community structure that is flexible enough to optimize individual and group performance under new and changing conditions. A VC should create a sense of sharing experiences, perspective, support, and trust between people working toward similar goals or solving problems together. Some of the issues related to the operations of VC:

- What are metrics for community Web site performance?
- Risk assessment and management, configuration control and management project plan.

The following discussion present a framework for virtual teams on demand (VTonD) using the HBDI principle as explained above. In addition, the framework distinguishes between three types of teams: quality, knowledge, and innovation, supporting SLL, DLL, and TLL, respectively. The three types of teams generate quality ideas, knowledge ideas, and innovation ideas, respectively.

The objective of "VTonD" is to establish a mechanism by which team construction is performed based on team function by employing HBDI technique.

Team Types/Functions

Previous research in the area of linking HBDI to organization and team innovation [Leonard & Straus, 1997] makes a very strong case for the use of the HBDI (Herrmann Brain Dominance Instrument) and whole brain concepts to foster creativity and innovation, build and manage productive teams, and communicate more effectively. This article provides a holistic approach to teams functions and structure in organizations and develops idea generation life cycle of the different types/functions of teams

Three types of teams or team functions are identified: Quality, Knowledge, and Innovation. Most organizations establish quality teams as a component of total quality management program. Quality teams (QT) generate quality ideas (QI) based on structured databases to improve process efficiency and reduce costs. Recently, on the other hand, new areas of systems such as knowledge management systems and strategic and competitive intelligent systems required the construction of different types of teams. As a result to these emerging systems, this paper constructs Knowledge and innovation teams as extensions to quality teams. Knowledge teams (KT) augment structure databases with unstructured and semi-structure information to come up with further improvement to processes.

Knowledge, including tacit knowledge, is shared and accumulated through social exchanges and informal organization, such as meetings and other types of social activities. IBM's project "Knowledge

Figure 5. Virtual Teams on demand: Individual and team profiles and team construction (Bold lines on the top left circle indicate profiles) (Note: the position of the little circle indicates the strength of the quadrant)
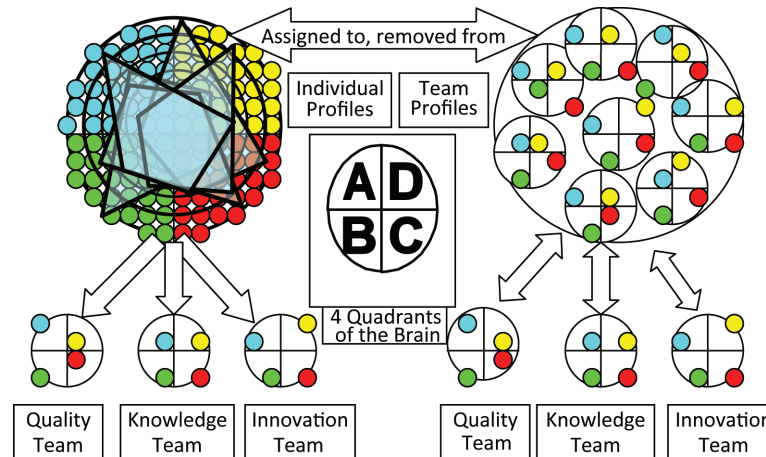

Socialization" is an example of how tacit knowledge could be shared through story telling. (http://www.IBM.com) An article reported the results of a study that highlighted the importance of humanistic and entertainment approaches to facilitate tacit knowledge sharing and elicitation (Desouza, 2003). This is an important point because it will impact the identification of the relevant candidate quadrant of HBDI to KT function as well as the inter-team communication link, namely quadrant C. KTs generate knowledge ideas (KI), such as improving customer care, after sales customer satisfaction, and meeting management.

At the final level, innovation teams (IT) uses the same information/knowledge as KT, in addition to external information/knowledge, as well as sharing ideas among processes and organizations. Normally, it dwells in depth on current process assumptions and will lead to fundamental changes in these processes. Innovation teams generate innovation ideas (I^2) that will lead to maintaining and/or improving the competitive advantage and devising new strategic directions for organizations operating in the global economy, such as new product development, new market penetration, new quality checks, and innovative advertising campaign. When discussing types of teams, we refer to team types as team functions also. This is needed to support the notion of one team generating all three types of ideas.

Pictorial Representation of the VTonD

The first step is to store individual and team profiles using HBDI techniques. Once these profiles are stored, team membership selection, composition, and transfer should be conducted dynamically so that team and individual satisfaction and performance should be maximized. Figure 5 demonstrates the profiles of members and teams. New teams will be constructed based on the major intended function: quality, knowledge, innovation, or a combination of the three. Members will be transferred from one team to the other to bring harmony and complementary functions to teams. In addition to team membership, leaders of teams should be selected based on the map between team function, members' profile, and team's profile.

Figure 6. Architectural design of the creative thinking framework. (Single and two-sided arrows represent one-to-many and many-to-many relationship, respectively
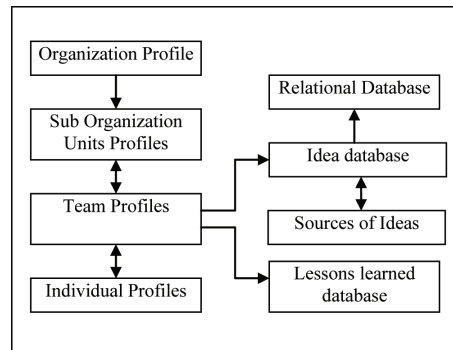
Architectural Design of the Databases

Figure 6 demonstrates the databases involved in the architectural design specifications of the framework. Based on the figure, here is a sample list of use case scenarios:

- create the profiles of the organization, organization sub-units (such as marketing, production, accounting, and purchasing departments}, teams, and individuals
- update the above database of profiles, if needed
- Verify and validate ideas
- Store/update ideas and lessons learned
- Remove profiles from teams and individuals
- Update relational database from ideas database
- Add an individual profile to a team
- Remove an individual profile from a team
- Recompose team profile
- List team profiles
- List team members profiles
- List ideas and lessons learned generated by respective teams

WEB ANALYTICS WITH AN APPLICATION IN BUSINESS INTELLIGENCE (BI)

According to Thomas Davenport, analytics represent a subset of business intelligence. While BI can answer questions such as "what happened; how many, how often, where; where exactly is the problem; what actions are needed", analytics can answer "why is this happening; what if these trends continue; what will happen next; what is the best that can happen". From this perspective, we can asses a Web Analytics Maturity Model could borrow from the TDWI model. (www.tdwi.org)

This section contains discussions of Web analytics maturity model and BI maturity model. Then it presents an application for BI in human resource appraisal.

Web Analytics Maturity Model (Hamel, 2009)

Overview: Jim Sterne, dubbed as the "godfather of web analytics", was pushing for online marketing as early as 1994. In his "E-Metrics: Business metrics for the new economy" paper published in 2000 he mentioned that "while all e-business managers clearly recognize the tremendous value of e-customer analytics, most lack the staff, technical resources, and expertise to harness and put to effective use the flood of raw data produced by their Web systems". A decade later, we can only admit this statement remains true.

The Web Analytics Maturity Model (WAMM) is adapted and derived from proven models in fields such as business intelligence and process optimization, or inspired from models proposed by industry analysts and leaders. Based on the critical success factors contributing to the "use of analytics to make better decisions and extract maximum value from business processes", those are applied to a five level multi-dimensional capability maturity model.

The proposed model presents five maturity states:

*   Analytically impaired
*   Analytically initiated
*   Analytically operational
*   Analytically integrated
*   Analytical competitor

The six key process areas, or success factor dimensions, are:

*   Management, Governance and Adoption
*   Objectives definition
*   Scoping
*   The Analytics Team and Expertise
*   The Continuous Improvement Process and Analysis Methodology
*   Technology and Data Integration

Those maturity levels and key process areas defines common features and attributes as well as key practices that will significantly increase the likelihood of success and positive return of a web analytics program.

BI Maturity Model

Wayne Eckerson is the creator of The DataWarehouse Institute (TDWI) BI Maturity assessment tool, Director of Research and author of "Performance Dashboards: Measuring, Monitoring and Managing Your Business". The TDWI model main purpose is to "gauge where your datawarehousing initiative is now and where it should go next". Each of the six stages is defined by a number of characteristics: scope, analytic structure, executive perceptions, types of analytics, stewardship, funding, technology platform, as well as change management and administration.

The TWDI model addresses the business intelligence maturity, a term coined by Gartner analyst Dresner in 1989 as the "set of concepts and methods to improve business decision making by using fact-based support systems".

1. **Prenatal – Management Reporting:** Standard set of generic reports distributed without discrimination for actual needs. Inflexible and hard to modify, users tend to bypass the established solution.
2. **Infant – Spreadmarts:** Individual, disconnected spreadsheets and desktop solutions with their own set of data, metrics and rules that are not aligned with the organization. Although they offer a low cost and locally controlled solution, they prevent management from getting a clear and consistent picture of the organization.
3. **Child – Data Marts:** All knowledge workers are empowered with timely information and insight. Data is shared and standardized at the department level, offering a standard set of application, business data and metrics.
4. **Teenager – Data Warehouse:** Definitions, rules and dimensions are standardized across the organization and deeper analysis is available through interactive reporting and analysis. Queries crosses functional boundaries and the data warehouse becomes a tactical tool to improve process efficiency across the whole value chain, contributing to a fact-based decision making culture.
5. **Adult – Enterprise Data Warehouse:** There is now a single version of the truth, data becomes an asset as important as people, equipment and cash. Scorecards and dashboards contribute to align every worker with the corporate strategy. ROI becomes positive and new, unexpected ways of using this knowledge emerge as a competitive asset.
6. **Sage – BI Services:** Data is open to customers and suppliers, extending the value chain beyond the corporate boundaries. Knowledge workers don't have to switch context to analyze data since the data, information and insight is embedded into operational applications and contribute to decision engines (think of fraud detection, behavioral targeting, and automated applications). Business Intelligence becomes ubiquitous and value increase exponentially.

BI Application to Human Resources Appraisal System

On company has an HR appraisal system in traditional Entity Relationship Diagram (ERD) database system running of Microsoft SQL Server. A suggestion was made to migrate this application to a BI platform. Two alternatives were considered: IBM's Cognos as a third party software and using native facilities of MS SQL Services. The latter alternative was selected for ease of transformation from the current platform to the new one. The following steps were followed based on the standard method of Extract, Transform, and Load (ETL) for creating HR appraisal mart for BI platform:

1. **Extract:** data and relationships were selected from the traditional ERD and transformed into a star schema where all relations are linked to the fact table at the middle of the star. The fact table represented the key fields to be linked to the corresponding relations containing detailed information.
2. **Transform:** data in the traditional ERD were linked to data in the star schema and any inconsistencies in data definitions were removed.
3. **Load:** two years of data were loaded from the traditional database to the new star schema database. A pivot table-like spreadsheet appears for presentation of multilevel selected facts in columns and

rows and with results of evaluation in the body of the sheet. This will allow a drill down capability as well.

Now the company can display different facts and generate reports quickly based on the tables. HR manager can look for trends and exceptions in these reports and make decisions to remedy the situation. Also, the HR mart is considered as a repository of employees skills where weaknesses and strengths can be identified. Plan can be devised for training needs and incentives.

Web Content Management (WCM)

Introduction (en.wikipedia.org)

A web content management system (WCMS) is a software system which provides website authoring, collaboration and administration tools designed to allow users with little knowledge of web programming languages or markup languages to create and manage the site's content with relative ease. A rich WCMS provides the foundation for collaboration, offering users the ability to manage documents and output for multiple author editing and participation. Most systems use a database to store content, metadata, or artifacts that might be needed by the system. Content is frequently, but not universally, stored as XML, to facilitate, reuse, and enable flexible presentation options

A presentation layer displays the content to Web-site visitors based on a set of templates. The templates are sometimes XSLT files. Most systems use server side caching to improve performance. This works best when the WCMS is not changed often but visits happen on a regular basis. Administration is typically done through browser-based interfaces, but some systems require the use of a fat client.

Unlike Web-site builders, a WCMS allows non-technical users to make changes to a website with little training. A WCMS typically requires an experienced coder to set up and add features, but is primarily a Web-site *maintenance* tool for non-technical administrators

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The Gartner Maturity Model for Web Content Management (WCMMM) (MacComascaigh, 2008)

Introduction: WCMMM outlines a model for assessing the state of an organization's Web content management (WCM) solution. CIOs and other IT leaders responsible for the strategic success of their organization's WCM strategy can use this model to articulate what they would like to achieve with their WCM solution, and to assess the level of change required to make that happen.

The Gartner Maturity Model for WCM Explained: A maturity model for WCM is a tabular representation of solution areas, such as Web authoring, workflow and solution architecture, together with a rating of

how "mature" or developed that solution area is and can become. It is a framework with which to assess the value of your current WCM implementation and how it suits your business or organizational needs.

Level 1 - Initial: This level features no standardized processes. Instead, different approaches are still applied on a case-by-case basis. This level is characterized by a lack of auditing, reporting and controls. Links between key business objectives and aspects of the WCM solution are being formed, but have yet to be converted into metrics. Formal executive sponsorship for these links is not yet evident. In most cases, the need for executive sponsorship is under-estimated.

Level 2 - Developing: The business objectives that can be addressed using a WCM solution are documented. Due to a lack of formal training, different individuals perform similar tasks using their own procedures. Platform diversity is being replaced by standardization. However, there is no formal communication of standard processes, and what documentation exists is weak. There is much reliance on the knowledge of individuals, so errors are likely.

Level 3 - Defined: Program definition for the WCM solution is complete. Procedures have been identified — for the authoring and publication of content, for example. These procedures are standardized, documented and communicated through training. Procedures are unsophisticated and formalized from existing practices. It is left to individuals to follow these procedures, and deviations are unlikely to be detected. Web sites still exhibit inconsistencies, and multi-site management is cumbersome. Governance is included as part of the overall strategy but remains difficult. Executive awareness is achieved. Solid progress from this level requires more formal executive sponsorship. WCM program goals are linked well to business objectives.

Level 4 - Managed: Tracking is in place to monitor the progress of the WCM solution against selected business objectives. It is possible to monitor and measure compliance with procedures, and to take action where processes are not working effectively. Processes are under constant improvement and constitute good practice. Automation and tools are used in a limited or fragmented manner. Executives in charge of the change management strategy champion the WCM solution internally, and communicate the benefits of that strategy to the whole organization. Full user adoption has typically not yet been achieved. Only one WCM interface is exposed to users, while repositories from other vendors can be accessed for legacy purposes either through federated search or back-end integration.

Level 5 - Optimized: Processes are refined into best practices, based on the results of continuous improvement and maturity modeling with other parts of the business. IT is used in an integrated way to automate the workflow, providing tools to improve quality and effectiveness, and making the enterprise quicker to adapt. Agility, scalability and effectiveness are broadly associated with the successful WCM solution. Benefits of the WCM strategy are realized and communicated to the organization as part of the continuing change management effort. User adoption is typically complete. The solution architecture is homogeneous and optimized. Migrations to this platform are complete, and cost reductions due to this strategy have been identified and communicated.

CURRENT TECHNOLOGIES FOR WEB BASED APPLICATIONS

This section discusses two technologies: Cloud computing (CC), and Internet Protocol Multimedia Subsystem (IMS), in addition to one new software development platform, namely Application Life Cycle Management (ALM) tools.

Cloud Computing (CC)

In compliance with Software as a Service (SaaS), Data as a Service (DaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS) models, cloud computing (CC) has recently emerged as a new computing paradigm for creating a shared and highly scalable (a.k.a elasticity) computing infrastructure from physical and virtual resources to deliver seamless and on-demand provisioning of software, hardware, and data as services. Cloud computing has all the necessary attributes and potential to support a global outsourcing environment with lower infrastructure costs, lower energy costs from eliminating hardware boxes, and improved scalability to provide computing resources to meet demand in an unpredictable global market. Current CC can be viewed as a global delivery continuum, where many organizations will originally evolve from initial business process outsourcing (BPO) environments, explore SaaS delivery to optimize that environment, and ultimately experiment with SaaS applications that are deployed in a Cloud "plug-in" model.

Cloud will revolutionize the delivery of technology. In the very near-term, it's adoption will likely be impacted as many firms, and CC will surely be at the forefront of new investment plans for organizations seeking more computing power for their money.

Speaking at the Microsoft Azure Transitioning the Cloud conference, held at the Burlington Hotel, Dublin, Ulf Avrin, senior partner at Tellus International Limited, told the conference he believes that up to 67% of cloud adaptation over the next two years is likely and such an adaptation would represent a huge shift in the way organizations do business.

In two separate surveys, cloud computing and mobile application development, were listed as the top two job security in IT. That's where the IT jobs are expected to be, according to 2,000 IT professionals recently surveyed by IBM. In another survey, when asked about the top technology trends affecting application development, survey participants reported innovations in cloud computing/virtualization and mobile as the most disruptive technologies currently influencing development projects across the enterprise.

Topics in cloud computing includes the following, as compiled by the author may include:
Technologies of CC:

- Tools and platforms
- Virtualization
- Standards for CC software development
- Security challenges and issues in CC
- Evaluating global cloud computing research test beds, such as HP, Microsoft, VMware, Oracle, IBM, Intel, Google, Amazon, and Yahoo
- Searching mechanisms of resources and applications
- Cloud interoperability: status, challenges, and guidelines
- Comparing cloud computing and Web services architectures

Software development issues in CC:

- Use of Software product line development practices
- Open source software development
- Construction of virtual teams and organizations
- Applications in global environments

- Applicability of software development models, such as agile methods, model driven architecture, and CMMI.
- Software agent deployment
- Software development management of cloud computing projects

  Applications and management issues in CC

- Performance evaluation of cloud computing applications, customer satisfaction, and total cost of ownership studies
- Applying business process re-engineering/improvement for migrating to cloud computing
- Role of social media and computing for global adaptation and dissemination
- IT governance of people, processes, and technology.
- Managing relationships with outsourced companied
- Cases of best practices, industry reports on experiences and patterns, and strategies for cloud computing adaptation
- egovenment applications to achieve global competitiveness: epratices and eservices in CC
- Cloud computing best practices

Internet Protocol Multimedia Subsystem (IMS)

Introduction

IMS was originally defined by an industry forum called 3G.IP, formed in 1999. 3G.IP developed the initial IMS architecture, which was brought to the 3rd Generation Partnership Project. (El-Sayed, 2006), IMS or IP Multimedia Subsystem has become the de facto standard for Next Generation Networks architecture. It will help facilitate the development and offering of many advanced multimedia applications, such as VoIP, Video, Presence and Location-based applications, Multi-player Gaming, Instant Messaging, and so on.

In (en.wikipedia.org), IMS is explained in as simple as possible way.

"The IP multimedia Subsystem (IMS) is a network functional architecture that is seen as a promising solution for facilitating multimedia service creation and deployment, as well as supporting interoperability and network convergence. IMS allows network operators to play a central role in traffic distribution, therefore being more than "bit pipes" IMS refers to a functional architecture for multimedia service delivery, based upon Internet protocols. Its aim is to merge Internet and cellular worlds, in order to enable rich multimedia communications. It is specified in the 3rd Generation Partnership Project. IMS is an end-to-end architecture that must support several kinds of equipments. In addition, IMS is intended to be "access agnostic", which means that service delivery should be independent of the underlying access technology. Thus, the use of open Internet Protocols is specified in IMS for better interoperability. IMS supports roaming between different networks (3GPP Release 6). It allows the network operator to play a central role in service delivery, and bundle attractive services with their basic access offer. Moreover, IMS should support the creation and deployment of innovative services by operators or third parties and therefore create new business perspectives. The faster development of IMS services should reduce the time to market and stimulate innovation. The combination of several services in one session, the single sign on and unified billing are expected to raise customer's interest and increase the revenue opportuni-

ties. In IMS the operator is aware of the actual services the customer is using. Therefore, appropriate billing schemes can be developed IMS is also designed to allow substantial network infrastructure and management savings, therefore improving cost effectiveness. It should decrease the investment threshold for new service deployment thanks to a uniform service delivery platform.

Future possible services on IMS networks are, for instance, Push to Talk over Cellular (PoC), Instant Messaging (IM), mobile gaming or a combination of several existing services (e.g. combination of IM and multiplayer gaming). IMS is intended to enable the deployment of "better and richer" services. It should enable the delivery of real-time IP based communications. It should make the integration of real-time, near real-time and non real time applications easier. It should enable the delivery of simultaneous conversational services in a single session. It should be access agnostic, i.e. allow a user to access its services by any supported media.

Although IMS was originally created for mobile applications by 3GPP and 3GPP2, its use is more widespread as fixed line providers are also being forced to find ways of integrating mobile or mobile associated technologies into their portfolios. As a result the use of IMS, IP multimedia subsystem is crossing the frontiers of mobile, wireless and fixed line technologies. Indeed there is very little within IMS that is wireless or mobile specific, and as a result there are no barriers to its use in any telecommunications environment.

IMS itself is not a technology, but rather it is an architecture. It is based on Internet standards which are currently the major way to deliver services on new networks. However one of the key enablers for the architecture is the Session Initiation Protocol (SIP), a protocol that has been devised for establishing, managing and terminating sessions on IP networks. The overall IMS architecture uses a number of components to enable multimedia based sessions between two or more end devices.

One of the elements is a presence server that handles the user status, and this is a key element for applications such as Push to talk over Cellular (PoC) where the presence, or user status is key to enabling one user to be able to talk to another. .With users now needing to activate many sessions using different applications and often concurrently, IMS provides a common IP interface so that signaling, traffic, and application development are greatly simplified. In addition to this IMS architecture means that subscribers can connect to a network using multiple mobile and fixed devices and technologies. With a variety of new applications from Push to talk over Cellular (PoC), gaming, video and more becoming available, it will be necessary to be able to integrate them seamlessly for users to be able to gain the most from these new applications. It also has advantages for operators as well. Apart from enabling them to maximize their revenues, functions including billing and "access approval" can be unified across the applications on the network, thereby considerably simplifying this area."

Quality of Service (QoS) Management Principle (Bertrand, 2007)

Two strategies are usually associated for providing a good level of QoS in packet networks. The first involves avoiding congestion phenomena. This can be done by implementing Connection Admission Control (CAC), resource reservation or simply by over-dimensioning the network (over-provisioning). A famous example of a QoS framework based on resource reservation is "Integrated Services" (IntServ) [34]. This strategy can also be used in Multiprotocol label switching (MPLS) networks using the Resource ReserVation Protocol (RSVP). The second method focuses on managing congestion. It usually relies on traffic differentiation for providing better QoS to most important flows.

We can distinguish between two types of QoS management schemes. The first aims at providing guaranteed QoS while the other is focused on Relative QoS. QoS guarantees like delay or loss rate bounds can be provided by resource reservation schemes. Relative QoS can be implemented by traffic differentiation. The end-to-end model adopted in IMS introduces several technical challenges, for example concerning QoS, privacy and billing. The main technological issue is related to interoperability. IMS mixes the points of view of IP, wireline telephony and mobile network operators. Moreover, it introduces new networking paradigms and provides specifications, not implementation-ready solutions. Finally, it uses some recent protocols like Diameter that have not been widely deployed. For all these reasons, interoperability may be difficult to achieve in IMS networks. One of the main motivations for IMS is to enable the delivery of real time multimedia services using IP related technologies, but IMS has to manage the different access related constraints imposed by heterogeneous access technologies (e.g. handover in radio access networks). In particular, this makes the establishment of end-to-end QoS guarantees quite difficult.

IMS architecture (_____, IMS, IP Multimedia Subsystem tutorial)

IMS provides a unified architecture which can be divided into three layers:

- Transport and Endpoint Layer
- Session Control Layer
- Application Server Layer

IMS Transport and Endpoint Layer: This layer initiates and terminates the Session Initiation Protocol (SIP) signaling, setting up sessions and providing bearer services including the conversion from analogue or digital formats to packets. It also provides the media gateways for converting the VoIP data to the IMS format.

IMS Session Control Layer: This layer contains what is termed the Call Session Control Function (CSCF) which provides the endpoints for the registration and routing for the SIP signaling messages, enabling them to be routed to the correct application servers. The CSCF also enables QoS to be guaranteed. It achieves this by communicating with the transport and endpoint layer. The layer also includes other elements including the Home Subscriber Server (HSS) that maintains the user profiles including their registration details as well as preferences and the like. It includes the presence server essential to many interactive applications such as PoC. A further element of the session Control Layer is the Media Gateway Control.

Application Server Layer: The control of the end services required by the user is undertaken by the Application Server Layer. The IMS architecture and Session Initiation Protocol (SIP) signaling has been designed to be flexible and in this way it is possible to support a variety of telephony and non-telephony servers concurrently. Within this layer there is a wide variety of different servers that are supported. This includes a Telephony Application Server (TAS), IP Multimedia - Service Switching Function (IM-SSF), Supplemental Telephony Application Server, Non-Telephony Application Server, Open Service Access - Gateway (OSA-GW), etc

Charging

IMS uses a unified billing/charging interface for all services with potential for savings by using common billing for all services. Offline charging is applied to users who pay for their services periodically (e.g., at the end of the month). Online charging, also known as credit-based charging, is used for real-time credit control of postpaid services. Both may be applied to the same session (en.wikipedia.org/wiki)

Potential integration of future IMS based services/applications with IPTV (Ahmad, 2009).

- New IPTV architecture scenarios provide foundation for support of tomorrows IMS IPTV services
- Link IPTV Control and OSS with mobile network trends
- Potential for savings with common billing for all services
- Unified IPTV Control and OSS with mobile network trends
- IPTV Evolution envisages IMS, Web, hybrid services for comprehensive content delivery
- Web and hybrid broadcast services will be integrated with IMS for comprehensive content delivery anytime, anywhere, any screen
- Ability to respond to mobile Internet trends, Web services, and profit centers

Current Research in IMS

Sample research from (Al-Begain, 2010):

- Energy-aware cooperative management of the cellular access network of the operators that offer service over the same area to identify amount of energy to be saves by using all network in high traffic condition.
- Enabling rapid creation of content, such as advertising and general data for consumption in mobile augmented reality based on the Image Apace mirror world services.
- A continuous quantity factor in the condition formula search using the data processing system called Cellular Data Systems which is based on Incrementally Modular Abstraction Hierarchy. It is used for effective development of core business applications that deals with objects that express continuous quantity factor.
- The Geobashing architecture for location-based mobile massive multiplayer online games.
- An analysis of the digital forensic examination of mobile phones.
- Media Share to leverage the end users' viewing and interactive television experience using IPTV development and delivery platform over IMS.
- A hierarchical semantic overlay system for semantic search and service matchmaking.
- Real time video adaptation in next generation networks.
- An IMS-based testbed fro fleet management services
- A heuristic buffer management scheme on Android to enhance video quality on digital handheld devices.
- A novel scalable architecture for efficient QoS to cater IMS services for handheld devices base on Android.
- Using Long Term Evolution (LTE) capacity and service continuity in multi radio environments.

Application Life Cycle Management (ALM)

ALM is the new software development environment for managing software development employing Agile Methods in particular and other methodologies, such Capability Maturity Model Integration (CMMI) designed by the Software Engineering Institute of Carnegie Mellon University. Several ALM exists in the market, such as IBM Jazz and Microsoft Visual Studio Team System (VSTS).

Both Gartner Group (GG) and Forrester Research published reports on ALMs. (Duggan, Light, and Murphy, 2008, West, et. al., 2010) In its report, GG put IBM ALM ahead of Microsoft VSTS ALM. However, the latter tool is the only one that provides two different templates for each of CMMI and AM. Therefore, this introduction opted to present Microsoft ALM.

The discussions below present overview of the Microsoft VSTS ALM. With Visual Studio Team System and the integrated process templates, teams can deliver predictable results, continuously improve and adapt, and effectively collaborate and communicate with team members and stakeholders. Visual Studio Team System includes Microsoft Solutions Framework (MSF) for Agile Software Development and MSF for CMMI Process Improvement. In addition, partner organizations offer processes including SCRUM, and Rational Unified Process (RUP) for Visual Studio Team system. These templates can be used as is, or customized to perform individual development processes. The list below include suggested outline for a presentation on VSTS (en.wikipedia.org/wiki):

FOUNDATIONAL PRINCIPLES

The following are the eight foundational principles, which form the backbone for the other models and disciplines of MSF:

- Foster open communication
- Work towards a shared vision
- Empower team members
- Establish clear accountability and shared responsibility
- Focus on delivering business value
- Stay agile, expect change
- Invest in quality
- Learn from all experiences

MSF MODELS

MSF consists of two models:

- MSF Team Model. This describes the role of various team members in a software development project. The members of this team would be:
  - Product Management: Mainly deals with customers and define project requirements, also ensures that customer expectations are met
  - Program Management: Maintains project development and delivery to the customer

- ◦ Architecture: Responsible for solution design, making sure the solution design optimally satisfies all needs and expectations
- ◦ Development: Develops according to the specifications
- ◦ Test: Tests and assures product quality
- ◦ Release/Operations: Ensures smooth deployment and operations of the software
- ◦ User Experience: Supports issues of the users

One person may be assigned to perform multiple roles. MSF also has suggestions on how to combine responsibilities such as the developer should not be assigned to any other role.

MSF Governance Model

This model describes the different stages in processing for a project. The MSF Governance Model has five overlapping tracks of activity, each with a defined quality goal. These tracks of activity define what needs to be accomplished and leave how they are accomplished to the team selected methodology. For instance, these tracks can be small in scope and performed quickly to be consistent with an agile methodology, or can be serialized and elongated to be consistent with a Waterfall methodology.

- • Envision: think about what needs to be accomplished and identify constraints
- • Plan: plan and design a solution to meet the needs and expectations within those constraints
- • Build: build the solution
- • Stabilize: validate that the solution that meets the needs and expectations
- • Deploy: deploy the solution

MSF Project Management Process

- • Integrate planning and conduct change control
- • Define and manage the scope of the project
- • Prepare a budget and manage costs
- • Prepare and track schedules
- • Ensure that right resources are allocated to the project
- • Manage contracts and vendors and procure project resources
- • Facilitate team and external communications
- • Facilitate the risk management process
- • Document and monitor the team's quality management process

MSF for Agile Software Development Methodology

The MSF for Agile Software Development (MSF4ASD) is intended to be a light weight, iterative and adaptable process. The MSF4ASD uses the principles of the agile development approach formulated by the Agile Alliance. The MSF4ASD provides a process guidance which focuses on the people and changes. It includes learning opportunities by using iterations and evaluations in each iteration.

MSF for Capability Maturity Model Integration Process Improvement Methodology

The MSF for Capability Maturity Model Integration Process Improvement (MSF4CMMI) has more artifacts, more processes, more signoffs on milestones, more planning, and is intended for projects that require a higher degree of formality and ceremony.

The MSF4CMMI is a formal methodology for software engineering. Capability Maturity Model was created at the Software Engineering Institute of Carnegie Mellon University, and is a process improvement approach that provides organizations with the essential elements of continuous process improvement resulting in a reduced Software Development Life Cycle (SDLC), improved ability to meet the cost and schedule targets, building products of high quality. The MSF4CMMI has extended the MSF4ASD guidance with additional formality, reviews, verification and audit. This leads to a Software Engineering Process (SEP) that relies on process and conformance to process rather than relying purely on trust and the ability of the individual team members. The MSF4CMMI has more mandatory documents and reports than the agile version, and this more formal development process reduces risk on large software projects and provides a measurable status. One of the benefits of using the CMMI process is the standard evaluation by which one can compare the ability to develop software in other organizations.

Lab Components for MS VSTS

For education and training purposes of future students and professionals, the list below contains the components for establishing a laboratory with VSTS.

- Visual Studio Team System 2010 Team Foundation Server Workgroup Edition
- Microsoft Visual Studio Team Suite 2010 which includes: Microsoft Visual Studio Team Architecture, Microsoft Visual Studio Team Development, Microsoft Visual Studio Team Test (includes Microsoft Test and Lab Manager), Microsoft Visual Studio Team Architecture, Microsoft Visual Studio Team Development, Microsoft Visual Studio Team Test (includes Microsoft Test and Lab Manager), Microsoft Visual Studio Team Test Essentials (includes Microsoft Test and Lab Manager), Microsoft Visual Studio Team Lab Management, and Microsoft Visual Studio Team Foundation Server
- Visual Studio Team System 2010 Test Edition
- Visual Studio Team System 2010 Test Load Agent
- MSF for Capability Maturity Model Integration Process Improvement methodology
- MSF for Agile Software Development methodology

   Further research recommendations

- Agile methods and VSTS
- Capability Maturity Model Integration (CMMI) and VSTS
- Global software development in VSTS
- ISO implementation in VSTS
- Other model-based and agile methods and VSTS
- Comparative analysis of agile vs. CMMI software development: a case study

- Evaluating Usability of VSTS
- Developing distributed service oriented architecture in VSTS
- Testing approaching in VSTS
- Customization of VSTS for different methodologies
- Business intelligent and VSTS
- Comparing VSTS and UML standards

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