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Developing Agile Teams for Project Execution : A Cybernetic Approach

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Abstract

In a project oriented consultancy firm, with multidisciplinary capability, consultants have to be trained to develop a capability to **switch over** *from one domain to another or from one technology to another with ease and in short durations. This paper deals with an approach to develop such a competence in project team members. The approach and its application have been detailed in respect to software industry*

There are two aspects to this particular training approach: (a) Basic competence in delivering a project's requirements on time and with quality (b) Basic knowledge of the domains with which the software consultant will be concerned.

The method suggested here is applicable to people who are trained to acquire basic competence in software development and in the basic aspects of the domains. This paper deals with these aspects and the suggested approach is called 'Vegam' meaning Speed- to imply that it brings about quick change in Competencies of people as needed in the changed contexts. Whatever is explained here, has been tested and deployed in software projects. The entire method, thus makes the software engineer agile in both perception approach and delivery action. Thus the consultancy firm can devise flexible alternative approaches to software development and also build Agile **development teams**.

Keywords: *Agile development teams, ability to do, Competence, knowledge, process ability, reusable competencies, switch over, skill*

Introduction

Consultants by nature, deal with multiple scenarios and offer solutions to problems in these varying contexts. The nature of the problem and its defintion is often unclear in the beginning and evolves as the work progresses.

Large Software Consultancy firms deal with a number of clients. Each of these Clients have needs that are varied in their impact and in the area of work. Each of these cover differing scope in the value chain of the customer business. Hence the competence needed to address these and build software systems for these vary. The variation is in terms of the contexts, the technologies, the domains, application and the particularities of the application of software.

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Again, Consultancy is provided to achieve a variety of deliverables. The scope ranges from the high end consultancy to provide strategy, redesign of organizations, do prioritized implementation of projects and to build people competence to suit. In each of these, people competence needs to be aligned to execute work in these various scenarios.

Current Approaches

"**Competence** (or **competency**) is the ability of an individual to do a job properly." [1] Competence in people is a critical factor and asset that ensures quality, productivity, cost conformity and related qualities in the developed product. There is large variety in the kinds of products and solutions that the large companies must deliver, and hence the need for being agile. For a software development team, the standard Life cycle is similar for all projects people work on. There is a generic process which is applicable for this. Most state of the art training processes, use this similarity and impart knowledge of the primitives of the specific platforms that teams will work on. This is generic enough and the task of aligning each individuals knowledge to the needs of the project and applying it suitably is left to the individual. This is a major gap in the generic process and must be addressed.

The challenge in this context stated above is to develop competencies in individual people to be able to address the varying needs of consultancy. This has been indeed a challenge and there have been several approaches to doing this. The larger industry standard approach to this is to build knowledge of primitives, through Training in a set of technologies that are likely to be used. Based on the projected needs, teams are trained through traditional methods. Training imparts knowledge that is the basis for the individuals to apply it to build deliverables. As and when projects with specific needs are received, already trained people are imparted an Induction Training, where they are oriented to the context of the project. They are then left to work on the

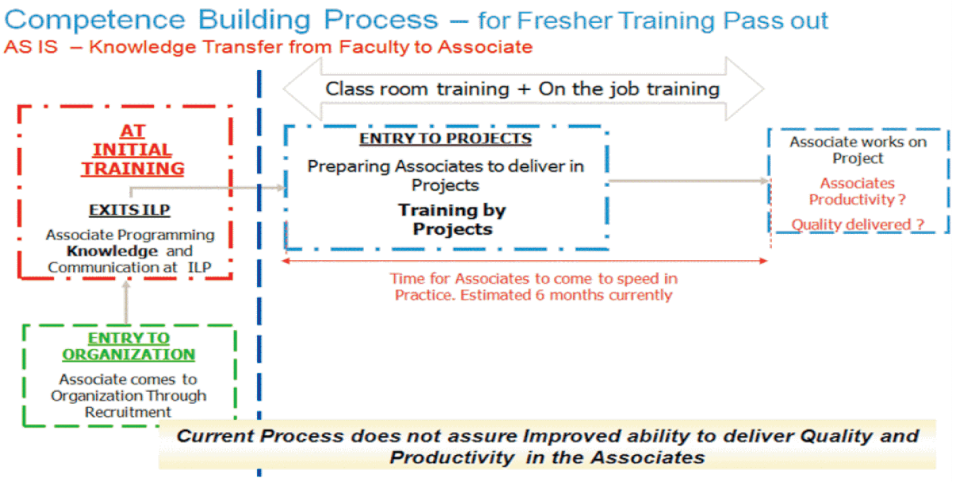

Figure 1: Current Approach to Induction into Projects in a Project Based IT Delivery Organization[1]

project and self train themselves to be able to deliver, with guidance from mentors where needed. Fig 1 below shows a typical process of how freshers are initially trained in core areas.

They are then inducted into projects. The induction and training methods here do not correlate well with the performance of the associates in projects since the training is generally for knowledge. The correlation seen in authors study ranges from 28-55 per cent[2]

This is one of the instances where quick adoption of the competencies needed for the project is required. In practice, with these methods, projects see a poor correlation between the performance in training and project performance. This approach brings "Subjectivity in competence building (since learning depends on the individual's skills and the appreciation of the problem)" [3]

Similarly, competencies related to domain and domain intensive functions like requirement elicitation and analysis are also similarly subjective. These are also based on knowledge of technology, domain and the processes involved. In view of this, the results are also subjectively achieved. Outcomes such as completeness of requirements, addressing non-functional qualities in the deliverables, Cost of Quality and the like are frequently seen to be low. Completeness of requirements has also been a concern to the Software developers, as a result of which the ISO 9126 and now the draft standard ISO Square series 25010 have been developed. This brings a baseline to the Business Analysts and to the developers, and guides them to ensure completeness of requirements and ensure Quality in deliverables. "The state of art in the Software Industry does not yet present a well established and widely accepted description scheme for assessing the quality of Software Products. … However, today it is difficult for a user or consumer of software products to understand the quality of software[3]." The larger intent of this is to make the explicit focus on Product or Deliverable quality and ensure that the requirements are complete. Consequently, the competence of developers in handling Non functional qualities is focused on by this standard.

The above are instances of the wide range of competencies that are needed and the current issues that are faced by the community in meeting them and thereby delivering quality software. Developing Competencies in these wide range of work areas is consequently a hard problem that needs to be addressed thru a comprehensive model and framework. The underlying theme areas are apparently Technology, Domain, Requirements, Process and some more similar ones.

Today's thrust to short delivery cycles, methods that focus on Agility in organizations to deliver immediately relevant solution, use of Agile Software methods being adopted widely to deliver prioritized functionality in short times and the like, point to the urgent need for methods that could develop Competence in very short durations.

Since all deliverables enable the realization of functionality and the connected business needs, the tacit underlying principles are the domain understanding and the underlying scenarios that govern the functionality and its exceptions, business rules etc. The underlying nuances guide the requirements and hence competencies to relate Business needs and software requirements and code are very critical to the delivery of quality products.

"Effecting change quickly contributes to flexibility. Change is the constant reality. Flexibility is therefore a desirable pervasive need. IT systems are now an accepted and constant part of infrastructure to support business. However, coping with business change necessitates corresponding changes in the supporting IT systems. This is an expensive and time consuming proposition today, because it is manually intensive, and because business and IT thinking are not sufficiently aligned within an enterprise. This situation can be addressed if we understand clearly the relationships between business drivers and business systems, and between business systems and information systems that support it. The understanding of this trace between the relationships is an act of alignment between business and IT. The former relationship is explored in a companion paper. The latter relationship, between business systems and supporting information systems, is explored in this paper[9]." Enabling flexibility is thereby an exercise in building methods that build this quick change in competencies of individual people and groups. The roots of this lie in understanding Business Systems and their architecture and understanding how competencies vary with the change in the Business systems.

For instance, the Competence needs for Strategy development would involve understanding of the Business, the Critical Issues, existing and possible extents to which these parameters can be improved, Understanding of the AS IS Processes, the possible TO BE states and the criticality in them and others.

Similarly in Requirement gathering will need competencies like Business Process Mapping, the needs understanding of various stakeholders, the techniques to elicit them and many more. In this way every offering in Software or general consultancy will need specific competencies and understanding of the context and domains to be able to deliver results. Ideally, the entire set of competencies needed to work on the varying needs of the customers in a Consulting Organization are so wide that they all cannot be possessed by any few individuals. It is therefore necessary to have a Framework or Methodology to address these situations.

Problem Defintion

The problem therefore is to develop a model that can provide:

1. Competencies that ensure ability to deliver in the various scenarios and work areas
2. Competencies to understand Business and its relationship with Software and enable develop quality products
3. Frameworks that can quickly enable the people to change and adopt their competencies to changing needs
4. Methods to scale the approaches to address the growing numbers
5. Include Domain and Scenario understanding into these so that qualities to address the problem is built

From the above understanding, our key parameters for building agility in teams are: Individual person Competence, Organizational competence, Business IT Alignment, the architecture of Business.

Understanding Competence

We have been using competencies for ages and have been delivering wonderful products and services since time immemorial. We have consequently had a number of definitions of Competence all of which have succeeded to a limited extent.

Definitions

The following definitions from PCMM ver2 are adopted for the purpose of this paper[9]:

1. Knowledge: The information and understanding that someone must have to perform a task successfully. Knowledge provides the basis for performing a skill.
2. Skills: The behaviors that an individual must be able to perform in order to accomplish committed work. Skills may involve behaviors that directly accomplish the task or that provide the support of, or coordination with, others involved in accomplishing tasks
3. Process ability : The capacity to perform individual skills in the specific sequencing or method used in the organization to coordinate activities among individuals or groups, and to adjust the performance of skills, as necessary, to maintain an orderly flow of work.
4. Workforce capability: The level of knowledge, skills and process abilities available to the organization in each critical workforce competency for performing committed work. The capacity of the workforce for performing work or for achieving specified levels of performance. Workforce capability is often measured for each workforce competency.
5. Workforce competency: The People CMM refers to workforce competencies as a cluster of

knowledge, skills and process abilities that an individual should develop to perform particular type of work in the organization.

Meaning of Competence

Competence is the cluster of Knowledge, Skills and Process Abilities needed to do required work. This will be the basis on which we will understand Associate Competence. Further, Process ability is knowing the process steps that must be executed to build the deliverable. It follows that we must know the deliverable to be able to define the process steps. Hence Competency has to be specified as a deliverable slice only. Knowing HTML is Knowledge, Being able to build an HTML Page is Competence. Competence implies 'being able to do', while knowledge implies 'having the information and understanding needed to do'. The differing is significantly clear.

Skill can simply be understood as the 'relationship the individual person has with the various interfaces he deals with when working to deliver.' This in simple words would represent the internalization of the process steps and the various interfaces involved in performing the work. This would therefore support the productivity aspects of the competence.

If the person executes the process steps correctly he delivers quality. If he executes it fast he has internalized the process steps and has understood the interface responses. Together, he has the 'Ability to do'.

This is the understanding that the PCMM ver2 gives us about what competence is. We use this understanding of Competence in the rest of this paper.

In order to build an 'Ability to do' in working on various Business and IT Solutions, we will look at the variety that there is in the products or deliverables that our Teams normally build and how we can meet the variety quickly by building the competencies quickly and effectively.

Factoring in Domain Contexts

Domain knowledge refers to understanding of specific businesses like Insurance, Retail and the like. Each domain has specific processes, markets and Business rules that define the specific scenarios in the which the software will operate. The contexts are both local and global and hence impose specific features like multi- language features, global standards processes and laws. Even if it is one domain, it is necessary therefore for any software developer to acquire competence in multiple contexts in the domain. Some of the common ways in which contexts and domain are embedded in specific applications are in the form of non – functional quality characteristics such as performance, security, usability and are typically common to multiple domains[2]. It is relevant to recognize that the scenarios prevalent in Domain Industry are important and drive the Non-functional qualities and the particularities of the process steps used to realize the results.

Consequently, it is necessary for the developers to be agile, with the ability to quickly switch over from one context to another, to save money and time.

Proposed Approach

The paper discusses in the next few pages, the approach that will lead to the solution to the problem. This approach is called 'Vegam' meaning Speed. It is based on the ideas discussed in this paper earlier: (a) that Competencies needed to build deliverables are actually slices of deliverables. (b) that deliverables are structured in similar patterns, specific to each vertical industry segment. For instance every organization in a Vertical has similar requirements since their value chain is similar and hence they have similar deliverables.

The two ideas integrate in the Deliverable Breakdown (DBA) and enable us to identify competencies easily. Competence needs are deliverable derived. In the subsequent pages of the paper, we detail the above and the way this competence is built into the individual associates and Teams.

Understanding the Patterns in Deliverables

In a wide variety in the deliverable sets that consultants offer to clients to address various problems, there appears to be patterns that exist in the organization of the problems as also the solutions to them. For instance, all web application Portals that are developed for managing Purchase or Sales or interactions between the Vendor and the Seller, are similar in the basic functionality they execute (i.e) they all are interaction tools between 2 parties, and the interface components are also similar. From the technology perspective they are similar but the scenarios in which they work are different. This way we can identify the similarity and organize the building of systems and the process of developing them. Reusability is thereby present in both technology components and competence building. This similarity and reusability is identified based on such relevant pattern seeking approaches.

Manufacturing Industry has matured substantially in methods and models to ensure quality and productivity. Software is adopting the well practiced ways that manufacturing industry has perfected. First among them is the principles and practices of Total Quality Management to ensure deliverable or product quality. Process Quality Maturity has been one of the earlier practices that Software Industry has picked up, which resulted in standards and maturity models like the ISO 9001, Capability Maturity Model CMM of SEI and similar models. There are many other practices which can be adopted like developing 'Standard Operating Procedures' for product Building, Competency Models for ensuring ability to deliver quality in deliverables, Ways to trace Requirements to operating procedures, to name a few possible adoptions from Manufacturing Practices. Some instances of adoption of these ways are visible – such 'Operating Procedure Defintion'[6], Productivity Improvement methods using manufacturing Practices [7] and the Requirement Analysis methods to ensure traceability of requirements with business objectives [8]. Some of the practices that the author has seen are also used in the following sections of this paper.

Building Manufacturing Systems is similar to Software Systems building [10]. Infact this parallelism is visible in manufacturing systems and is a dominant approach from a long time. Manufacturing methods have the approach of breaking down the product into components and looking for similarity in the manufacturing techniques that can be repeatedly used in each of the components of the product. For instance, all Jigs use similar methods for hardening and later fixing them on machines etc. Likewise, the drilling technique is similar in every component but for the sizes etc. Nuts and Bolts are similar components that are reused a number of times in various products to bind components. These techniques are at the lowest level of granularity and hence are highly reusable. Competencies are built at these granular level and they become reusable to build many different products and services. This is a very significant pattern in the manufacturing process and has stood the test of time. Software also has leveraged this and there are many instances of such reuse. One prominent example of this is the ERP Products.

The Enterprise Resource Planning (ERP) Packages, are Configurable Software that cover the processes and transactions of the entire enterprise. They have leveraged many of the features of the reusability of software components based on the similarity in functionality. Workflow functionality in Purchase or Order Management is fundamentally similar in its functionality and hence is a reuse component. The competence to configure this feature in either of these workflows

would also be similar.

In order to use this feature in our present problem resolution, we look at some of the patterns that are visible and which may be useful for our purpose.

Patterns in Businesses

1. Vertical alignment of Businesses: Businesses in Similar Industries have similar needs for IT Systems. This is because in a given vertical, businesses service similar customers, and hence need similar functionality and features. Thus competence needs for technology and domain would be similar.
2. At a granular level of deliverables, the components or tasks sets are similar. The Unique set is usually smaller than the total list. This is because similar competencies are needed to fulfill the function.

Deriving Needed Competencies

Competencies needed to do work or build software are essentially derived from the defintion of the deliverables. This has been the practice both in manufacturing and other industries and is more of common practice than a specific technique. This is another instance where the parallelism of manufacturing and Software Industries is visible[10]. Typically when Bills of Material are developed, the Product is broken down through a Product Breakdown and at the lowest part or component, the work breakdown is created. This Work breakdown is the method of building the component or part and is in standard nomenclature referred to as the Operating Procedure or the Standard Operating procedure to build that product or manufacture it. The unique feature of this breakdown is the traceability of the qualities that the final product intended to meet. The qualities in the component for which the Operating procedure is built will embed the qualities relevant to the final product in this component. Consequently, when assembled, the individual component's qualities will add up to give the final product qualities. For instance, an air-conditioning system is intended to give 20deg C temperature and a flow of 10 fpm in a room. The fan and the chiller etc are designed to meet this need. The fan speed is fixed at 1000 rpm. When there is a change in need and we need a temperature of 15deg C and an air flow of 15 fpm, the operating procedure will clearly articulate that the increase in the fan speed should be 1200 rpm. This trace between the component quality and the final product quality is the unique feature that drives manufacturing and hence the sustainability of the processes.

Using the same principle in Software, we derive the granular components of the final deliverable via a deliverable breakdown process akin to the product breakdown of products. The lowest slice or component will be the deliverable slice which will have a requirement, a set of qualities relevant to the use and scenarios, and a context in which it applies. This is a competency slice as defined and understood in an earlier para of this paper. For instance, in a Web Application development built on Java / J2EE, the lowest level components will be HTML Pages, Javascript validations, Session management, Exception Handling and the like. These have a requirement defintion, a context and a set of qualities including functionality. These are then Competencies that the developer must have in order to be able to build the web application. Typically, the set of individual competencies identified this way will far exceed the unique list, since the competencies are granular and are reused in particular sequences to meet specific deliverable requirements. This is the crux of the reusability of competencies in differing contexts.

Figure 3 illustrates this breakdown for a typical Web Application Framework. Each of the deliverable slices shown in the colored cells under Reusable techniques, are the competencies needed to build a Web Application. Please note for each role that is played – e.g. a UI developer- the list

Offering	Sub - domain	Sub - Domain 2	Re usable techniques			
			GUI	Action Handler / DD	Middle Tier	Back-End
Development	Web-App Development	Login and Security	Create HTML page	Session management	Password encryption/decryption	Query to validate login information
			Javascript validations	Service integration	Database connection management	Dynamic menu generated from database.
			JSP Tags	Redirection to appropriate view	Exception handling	
			Struts tags in JSP	Exception handling	Connection leakage	
			JSTL/Core tag libraries	Filters		
			Post method	Role declaration in DD		
				URL Patterns in DD		
		Create/Save new data	Create HTML page	Capture request parameters and populate DTO as required by service	Database connection management	Query/stored procedure to insert data
			Javascript validations	Reading property files	Exception handling	Throw exception in case of duplicate records
			JSP Tags	Session management	keeping database records in VO.	Dynamic form fields fetching from database.
				Service integration	Connection leakage	
				Exception handling		
				Redirection to appropriate view		

Figure 3: Deliverable Breakdown Asset (DBA) – Breaking a Web Application to Derive Competencies.

of competencies needed to do work shown in the column 'GUI'. This list has many competencies, but when the unique list is created out the number of competencies for this role is short. This is how reusability is manifest in the model.

Each of the cells in the Breakdown, under Reusable techniques, are competencies. A Competency Menu can be derived for each Role in the team, containing the Unique Competencies needed by people playing that role. Organizations that work on various areas of work building various deliverables, will develop 'Competency Menus' for various Roles for various deliverable. These will be the basis on which the organization will organize its competency building plan and quick ramping of the Competencies needed at short notice.

Agile Organization

Agility "In business and software development, agility means the capability of rapidly and efficiently adapting to changes"[12]. Among the many characteristics that need to change, Competence to quickly adapt to the newer demands of the problem is a key capability. Thus for the purpose of this paper, we can define an Agile Organization as one (apart from others) which has executable Competence Menu's and related artifacts, for every possible scenario that may be needed in the organization in the coming 1 to 2 years. This will give the people in the organization a capability to quickly switch from one competency set to another to cover different competency needs and save cost and time, because of the inherent embedded increase in productivity.

Building Competencies in Associates

Competency Building is based on the Competency Menu's derived from each of the specific deliverables that are to be delivered by each associates. Each Competency is specified by a Requirement that the associate has to execute. This would include all the Functionality and Non-functional qualities, the scenarios and the peculiarities imposed by the scenario.

The Competency Building Model

The actual building of Competencies in the Competency Menu is discussed. The method uses an artifact called 'Competency Asset' (CA) to define and detail the requirement. The CA has 3 sections. Section 1 has the requirement detailed out including Non –functional requirements. A case study with all configuration items are also included in it. Now, this becomes a case study that is executable. Each associate who has this competency will be able to execute it. To verify this, the associate executes the requirements in a virtual environment. He has to validate the execution by meeting the acceptance criteria mentioned in section 3. If he does not meet it, then he will have to train himself using the process steps detailed in Section 2 of the CA.

Section 2 provides an Experts Process Steps to meet the requirements.

Since we use predefined and standard assets CA's for building relevant Competencies, and since the Acceptance criteria in Section 3 is specified for each CA, Competency in an associate or individual is measurable. Every person can assess his competence using the scale shown below in Figure 4 and decide where he is on the scale. This provides a measure of the individuals competence in relation to peers, experts and the minimum line. Those who fall below the

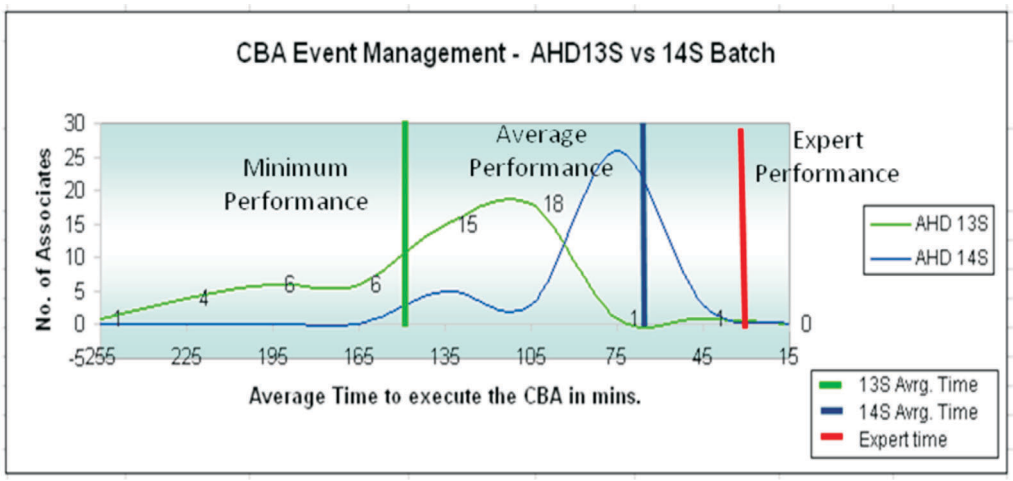

Figure 4: A Typical Competency Measurement Scale used in 'Vegam' to Ensure People are Competent

minimum line are not yet adequately competent and need to work on their competence. Their Skill levels are still not upto the mark, which means their internalization is not as needed. The figure also illustrates the differences that exist in peoples ability to adopt quickly. However, the method shows a high correlation between training and project performance and a high reliability.

This approach needs that the following be done by the Business leadership: (a) Identifying Competency Menu's for each of the relevant Roles. The Competency Menu contains the list of the competencies needed by the working groups or Project execution teams (b) Competency Assets for each of the competencies identified In the Competency Menus. These Assets are to be created and made available as a repository.

Learning to Switch Over

Contexts in which the software applications are developed embed the domain understanding. Domain and technology are integrated into one in the requirement definitions. When the same application operates in another context and domain, the requirements will change. The need to switch over to a new role to work on building software covering these new requirements arises in these kind of situations. For instance a person working on the development of a web portal for a retail application using Java/J2EE technologies. When he is moved into the role of a developer, for a support role for Service Portal in a pure service application, the domain, application change and the competencies change. Here the competencies change and he has to have the capability to execute the support functions like Change Request analysis, debugging, bug fixing and testing. The key to managing competence in this scenario is: (a) to identify reusable granular competencies needed for the support role from the corresponding DBA (b) Developing ability in executing these granular competency Asssets (CA) to meet the changed requirements thru a

short induction training program.

The induction program would consist of defining the Competency Menu with the list of relevant competencies that are needed for the person to perform the new role.

The time taken by an associate to execute and build the competence in each of the competency is small, in the range of a day or 2. When an associate has to, switch over from one project competency to another, he has to pick up the Competency Assets relevant to the new project and execute those Competency Assets. On an average each project role would need about 6-8 competencies or fewer. Accordingly, he would be able to build the ability in himself and be competent to perform the role. Effectively.

The team leader plays an important role in integrating the training of the individuals and creating a harmonious and effective team. Such an approach builds agile teams who will increase productivity, save time and reduce cost.

The entire approach is cybernetic in character in view of the several interacting dimensions involved in execution of the process. The above procedure suggested will ensure agility in the team.

Scaling the model to meet Organization's Competencies

In order to meet the continuously changing competency needs, it is necessary to create a repository of Deliverable Breakdown Assets (DBA) for the scope of applications and work that the organization foresees. Due to the Reusable structure of the work being done by the Organizations, the change in competencies needed will be a small percentage of those that were used in the previous plan period. This will have to be created afresh and kept up to date. This is an investment from the Organization to get the advantage of having Agile teams.

These ideas have been piloted and the following results were seen[8]:

1. Induction training times for people joining projects is substantially reduced by about 20-50 per cent.
2. Correlation between performance in Competence Building and Actual project performance correlates by nearly 90 per cent
3. Competency building can be automated and hence scalable to any order
4. Once the primitive knowledge needed is there in the associate, competency building needs less faculty support as the Competency Asset CA guides the building of Competence

Conclusion

In today's dynamic environment, being agile is the key to survival and success. Agility in Software industry, as also in others, has many dimensions. Among them is the need to have agile teams who can quickly change to work on different projects needing newer competencies. Building an approach to develop agile teams is discussed in this paper. The need for quick adoption to newer technologies is an essential feature of every organization. The key feature that all applications in a given Vertical function have similar needs and hence competencies needed is leveraged and the accordingly, the competencies are also reusable. This feature is leveraged in the approach 'Vegam', discussed in this paper of the vertical and horizontal alignment in the work. The need for an organizational focus on creating the necessary repositories for the Competency Assets and other related assets is important. Leveraging these, people or team competencies can be quickly built. The method has show good results and high correlation between training and project performance.

The potential for scaling this process is discussed. In a mature environment, this can be made a default approach to competency building and has the potential to become a community wide approach. The impact is expected to be substantial and work on these aspects is being done by authors.

Future Directions

The next step in building Agile teams is to organize tacit and explicit knowledge available with the experts. A Framework that can form a basis on which the knowledge assets capturing valueable experience and not easily available solution approaches, patterns and the like, can be stored. Ways to retrieve this knowledge is a key approach that is still a topic of research. Such Frameworks are very value adding and will substantially impact the use of these assets, leaving a lot of effort saved. This will also make available ready to take knowledge and thus make the systems agile. Such framework design and its piloting are key activities for the next year or so.

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