

Knowledge and Maturity

A Q:PIT Ltd Paper

There has been a lot of talk and ink used over the past few years about maturity and capability and measurement and models. The origin of this lies in the success over the past few years of products such as the Software Engineering Institute's CMMI[®] (Capability Maturity Model Integration). This article tries to go beyond the jargon and explains why, if properly understood, an approach such as this can be useful to project management.

Understanding what is really meant by terms such as capability and maturity can significantly improve the quality of any improvement programme, ensuring that the focus is set on what really matters rather than on trying to implement a theory.

The Project Manager: Generalist or Specialist?

As we progress in complexity, the role of a project manager gets more and more complicated. One of the questions that have been floating about is what is the role of the project manager? Should she be a generalist, understanding the work of the team members, being able to do some engineering herself, aware of the difficulties and the pressures that her staff is facing, able to speak to them in their own job's language? Should he be a specialist, knowing all the key project management techniques, skilled in various tools and approaches, able to juggle earned-value and relationship diagrams?

The project manager is ultimately responsible for the quality of the project, which includes the quality of the delivered product, but many other things at the same time. The project manager needs to be able to balance quality, cost and time in order to ensure an appropriate delivery. The PM needs to understand the needs of the many stakeholders, compensate for the technical limitations, and know the skills that are required and/or available for the project.

The project manager needs to be able to tell the management team what is really happening on the project, deliver the bad news as well as the good, recommend or deliver reward and punishment equally. And at the same time, the project manager needs to be sympathetic, supportive and available for people to come and confide their problems, issues and risks. While reassuring the management in one meeting that the budget can be cut, the project manager needs to reassure the team in another meeting that the additional resources will be available...

As far as I am concerned, the question as to whether she should be generalist or specialist is probably the wrong question. The right question is whether it is reasonable for a single person to be expected to be a project manager as it is fairly obvious that she needs to be all things to all people at all times.

This is where the concept of maturity and capability become equally important.

Management and Leadership

I generally recommend that organizations consider a hierarchy based on an inverted pyramid. The people who are traditionally placed at the base, the engineers, and the factory floor are the only people who really work for your customers. They are the ones that deliver the products, the services and the quality that your customers expect. Everyone else in the company has a single function: ensure that the people who report to them have the environment they need to be able to do their work effectively and efficiently, delivering maximum quality for minimum cost.

Most organizations understand this and set up levels of responsibility to ensure that things are running smoothly. Some level of authority is required in order to ensure that a person is doing the right thing in order to allow someone else in the chain to be able to deliver. However, the good manager needs to understand that there is no authority without trust. If your people trust you, they will listen to you and follow you. If they do not trust you, they will not, no matter how much authority and sticks and carrots you wave about. Dictators have very little authority in reality. While they may get what they want for a time, one of the key results of a dictatorship, in business or in politics, is to create a black market, a level of dissatisfaction that leads to a steady undermining of the viability and financial stability of the structure.

The main job of the manager, whether project manager or other, is to motivate people and this needs to be done through leadership. Motivated people not only do a good job, but seek ways in which to make

a good thing even better. For this to happen, the manager needs to know what is going on, understand the issues, listen to the people and demonstrate a desire to improve and correct the situation.

Before a manager can truly manage a team, she needs to understand every aspect of that team, from both a human and a technical point of view. I will feel more comfortable with a manager who can ask me how my wife's operation went on the right day, then one who does not appear to ever consider whether I might have a life outside the office. In addition to that, when I go to tell my manager that the wimble has faltered twelve times in a row, I would hope that she knows what this means (at least superficially) rather than requiring me to go into a detailed technical explanation to which she will stop listening after a few minutes (probably because I cannot explain it in terms that can be understood by normal humans). In addition, the manager needs to be trusted by her managers - this means that she needs to demonstrate that she is aware of the real situation on the project, the issues with the budget and schedule and the risks that the project is currently facing.

Regularly I face organizations that speak of project leaders, while others speak of project managers. There is more than a difference in words here. If I was to compare this to an army, I would say that the leader charges ahead of his troops, while the manager stays at the back looking at a map. Both are needed in most enterprises. And frequently, both roles need to be filled by the same person. How can you remain in front and behind at the same time? How can you be aware of the sweat and fear of your troops (as a leader) and the position and movements of your stakeholders (as a manager) at the same time? How do you go about balancing a ridiculously small budget and motivate your people to do an absurdly large job at the same time?

In other words, how do you get to have all the knowledge you need to do this very demanding job?

Knowledge Based Leadership

Let's assume for a moment that you are a reasonably normal person. Who would you rather have at your side: a leader or a manager? While I am sure that you understand that both are necessary and you would like to have a combination of both, considering that you have to choose, would you rather have a leader who stands by you and supports you, or a manager who stands by the shareholders and supports the budget? I know I am phrasing the question in a way that makes the answer nearly unavoidable, but I don't mind cheating when it serves my purposes.

The leader is the person you want to follow; the manager is the person who pushes you. If you consider that a manager's role is to motivate people and to make sure that they are doing a good job, it seems to become obvious that what we really need are project leaders rather than managers.

But leadership requires knowledge at all levels: technical and financial as well as personal. The project leader needs to understand what her team is capable of doing and what the limitations are. And then, she needs to be able to defend that position in the face of her own management: demonstrate that it is not reasonable to take on another project, to accept more work, to allow for the new requirements. She needs to be able to show the facts and sell the concepts that her team has limitations and that changes being demanded by the marketing people will only create more trouble and reduce the quality. More projects than anyone knows have failed miserably because the team was required to add features to a project that was already at its limits. Many project managers make the same mistake: they define what they consider as reasonable productivity rates (say, 80%) and assign them tasks to fill up that time; then they have a series of action logs in which they list all the additional actions that team members need to perform in addition to the 80%; then they organize meetings that are not prepared but last all morning to discuss why people are not meeting their objectives; then they ask for more management and progress reports; then... After a while, team members are assigned 150% of their time and have a series of tasks they need to accomplish in the rest of their time. The cause is simple: the project manager does not know what is going on, cannot explain it to her management and moves into panic mode.

Leadership will seek to avoid this by ensuring that the knowledge is available and shared, and that the knowledge is based on data and facts rather than just feelings, impressions and assumptions.

The rewards of good leadership are a self-fulfilling prophecy. As people see that the leadership is listening to them and knows what is going on, they become motivated to communicate and share. Soon, they are identifying the deficiencies and the weaknesses in the system and defining manners in which they can help improve their work practices and the results of their efforts. Thus a good leader will very rapidly find a good team, producing good results. By communicating more freely with each other and their team leader, the quantity of knowledge available to the team leader will rapidly increase. By using this knowledge constructively, the team leader is now able to increase the productivity of the team...

Unfortunately, most project managers need to get this ball rolling before they can get any of the benefits. This is where the improvement effort needs to get started.

Understanding and Leading Improvement

Setting up an improvement programme requires a number of key elements to be put in place. These include understanding what the objectives for improvement are. These should be well defined objectives that will benefit customer satisfaction. Following this, there needs to be a realistic baseline made of the current situation, with its strengths and weaknesses: we need to focus on improving, not on replacing what is working more or less well with something completely different and alien to the people who will be doing the work.

The improvement should be focused on ensuring that the people are being supported by the change, so that, in turn, they can support it. It is very easy (and frequent) to create a bureaucracy. In particular, when using a model to support an improvement programme, there is a temptation to do what the model says instead of trying to understand it. As a consequence, many people have established ridiculously complex and cumbersome systems in order to be compliant to CMMI, ISO or any other improvement model. They do not have more knowledge, they do not have more maturity or capability, they just have more paper and procedures. As a consequence, the people who need to do the work, the people on whom you depend for the quality of your services and products, are disenchanted and embittered. They are not interested in quality, because they see that management is not interested in quality. They are not interested in communicating their issues, because they realize that management is not willing to listen to them, who are doing the work - instead management is listening to expensive consultants and reading theoretical books.

If you want to establish a principle of leadership, you need to start by understanding the needs of the people who will be affected. That includes the needs of your customers, or potential customers, but also the needs of the people who are doing the work for them. They know better than any university what works and what does not work; they just have no way of getting their message across. The first thing that needs to be implemented successfully is an infrastructure that allows management to hear what their people are saying, and allows the people doing the work (the people at the top of the inverted pyramid) to know that management is listening, understanding and caring. A model, a tool, a consultant can help in this process, but remember to put your people first.

The CMMI

The Software Engineering Institute's Capability Maturity Model Integration product (CMMI(r)) is generally recognized as the de facto standard in process improvement. Its success ever since the original CMM for Software was first launched in the late eighties has been undeniable and many have tried to copy it or adapt it to their own needs. We have had Architecture CMM, Project Management CMM, People CMM, Systems Engineering CMM and many others. Some of them were developed in collaboration with the owners of the intellectual property, others were shamelessly ripped off. Some of them bring real added value, others bring only commercial benefits to the developers.

When the SEI developed the CMMI, and integrated the various high-quality standards that were out there into a single structure, they brought a fully integrated approach to engineering and management practices that is still not fully understood by most organizations.

Because of the reputation, past and specialization of the SEI in Software Engineering (it is after all the Software Engineering Institute), many still believe that the CMMI is just a software engineering methodology. The SEI defines its core market as "software intensive systems"; I have personally worked with organizations that had nothing to do with software. The approach that was originally created in the CMM structure is well known today, but still I find very few people (including process professionals) who understand its meaning, and therefore many are applying it in a manner that does not take advantage of the model.

Maturity vs. Capability

Understanding maturity

Maturity is an understanding of one's capabilities and abilities. It means that you know what you can do and what you cannot do. It means understanding your possibilities as well as your

limitations. With maturity, confidence replaces modesty and rejection replaces temptation. By understanding the consequences of what you have done and seeing the possibilities of what you could have done, you learn to be able to differentiate and make decisions based on a rational view of the world. Maturity comes with age. In traditional societies, maturity is typically respected as the elders are assimilated to the wise and the sage teachers.

Maturity in cheese typically means smelly, but that is the subject of another story.

The Concise Oxford Dictionary says...

mature adj. & v.

adj. (maturer, maturest)

1 a with fully developed powers of body and mind; adult. b sensible, wise.

2 complete in natural development; ripe.

3 (of thought, intentions, etc.) duly careful and adequate.

4 (of a bill etc.) due for payment.

v.

1 a tr. & intr. develop fully. b tr. & intr. ripen. c intr. come to maturity.

2 tr. perfect (a plan etc.).

3 intr. (of a bill etc.) become due for payment.

maturely adv.

maturity n.

[Middle English from Latin *maturus* 'timely, early']

Understanding capability

Capability has to do with being able to deliver, able to do something. The concept of capability is related to the usefulness of a practice, the effort required vs. the quality of the outcome. Everything is possible, but if the effort is greater than the benefit, the capability is lacking and the task was probably not done appropriately. The benefit needs to be understood in terms of quality as well as terms of cost.

The Concise Oxford Dictionary says...

capability n. (pl. -ies)

1 (often foll. by of, for, to) ability, power; the condition of being capable.

2 an undeveloped or unused faculty.

capable adj.

1 competent, able, gifted.

2 (foll. by of) a having the ability, fitness, or necessary quality for. b susceptible or admitting of (explanation or improvement etc.).

capably adv.

[in earlier use = able to take in or understand: French via Late Latin *capabilis* from Latin *capere* 'hold']

People, process, technology

It is generally understood that in order to be able to produce quality, we need to consider at least three key components: the people who do the work, the technology at their disposal and the processes they follow. These three elements need to work together and supplement each other in order to produce quality.

People

People are the most important asset of any organization (the word "organization" is used here to indicate any coherent organization, whether it be a department or a corporation - as long as it has consistent objectives and a consolidated management structure). Whatever else you have put in place, the people do the work. They may have all sorts of technology and processes and procedures and robots and tools and whatever else, but, in the end, only the people do the work. Everything else either reduces the work load or creates more work.

While people do the work, they also are the ones who are responsible for creating or resolving most of the errors and quality issues in your products. They are the ones who make the mistakes; they are the ones who find the solutions. The quality of your products, of your services, of your projects depends entirely on the people doing the work, nothing else. This is true whatever you produce.

Now, I expect that most of the people working in your organization are of human ancestry (there is the remote possibility that some extra-terrestrial Mork is working in your company, but I have never met one - yes, even the odd fellow kept at the back of the IT department, while he may not really appear human, is of human descent). The first consequence of using humans is that they make mistakes. Every one of us makes mistakes every day. Some of them are dramatic (such as the trader who sold 200000 share of a company for 1 yen each instead of 1 share for 200000 yen), others are just mildly annoying. In every case, they will have some impact on the quality of your products and services.

Process and Technology

Process and technology work together in order to support and assist the people doing the work. They aim to reduce the workload that each individual has to carry.

This is done by:

- Creating controls to identify errors as early as possible;
- Setting "fool-proof" systems that will avoid a number of errors being injected (at least until you find a better fool);
- Creating guidelines that will help individuals know what needs to be done next, in what sequence.

Process and technology need to work together and, most importantly, need to support the people in their work. This is true in your engineering work, in your creative work, but also in your project management and leadership roles. It is generally understood that you can no longer manage significant engineering projects using a slide-rule and a pad of paper: computer software is required for anything above two weeks or three people. A lot of energy and ink have gone into comparing the very many different project management tools that are currently available. Should we have an all-in-one solution? Should we have combinations of the best in each area? Should we have a network based tool? As a result of all this, the project manager sometimes appear to spend more time working at a computer creating charts and entering numbers than managing the project or leading the people. Again, the main asset is your people - the project manager should be managing the people, not the project management software.

Processes are there to support the project management as well as the engineers and the other managers. They are there to help you understand what you should or should not be doing, to help you to make the decisions you need to make to progress. The processes are closely related to your environment, including your corporate objectives and priorities, the technology and tools you use, what you can (and cannot) afford to do.

Understanding capability maturity

Process Capability Maturity is what the model seeks to measure. As we have defined previously, maturity means knowing what your possibilities and limitations are; process capability maturity means understanding what are the possibilities and limitations of the processes and work practices that are commonly used throughout the organization.

We are looking at two separate things here as we try to measure the situation:

- We are trying to measure the capability of a given process: does it deliver the expected results, is it understood, is it planned and measured, have the people doing the work been trained to do it, is it based on a described standard approach, are the results being measured and used to improve it...?
- We are trying to measure the maturity of the organization: what are the processes that are in place, are they being performed systematically by all teams and projects, is there an environment in place that supports and encourages quality and continuous improvement, do the people have the tools needed to do the work properly...

Measuring this is not a simple task - in order to measure something, you need a well defined scale. That is one of the key reasons the Capability Maturity Models originally came into existence: define a scale that can be used to measure companies and allow them to be compared. We want to know whether the company understands its capabilities and to what extent, before we trust them with our contract.

A company with a high maturity level does not focus on delivering what it promised, but on promising what it knows it can deliver. It understands the strengths and weaknesses of its processes and the manner in which they support the people working in the engineering department. High maturity does not mean that all is well; it does not mean that everybody is outstandingly capable; it just means that it has safeguards in place to ensure that the problem is really understood before the solution is suggested, that historical data and measures have been used in order to make an estimate that is realistic. And it means that this is performed systematically, at all levels of the organization, in all projects...

Naturally, when we talk about process capability maturity, we are looking at one aspect of quality. There is no guarantee that high levels of maturity will lead to high levels of quality in the delivery: we would have to consider the people doing the work and the technology they are using in order to get a more complete picture, but that is another story.

The CMMI structure

The CMMI has a well defined structure, which is a dynamic evolution of the one that was originally defined for the Software CMM, all those years ago. The CMMI does not give the solution, it gives the question. It does not tell you how to do things, but considers the results, the products that should be there, somewhere, in some form, if the practice has been carried out. So the model is organized in practices, which are each illustrated by their results rather than the activities or procedures required to generate those products. If we want to have a generic list of key practices that are recommended in all environments in which engineering is conducted and projects are managed, there is a lot of ground to cover. As a consequence, there are some 750 pages in the CMMI book. This is not a book you want to read from cover to cover, but it is a reference document, which you want to be able to consult and find the information when you need it.

For this reason, it is necessary to have a well-defined structure allowing you to find back relatively easily the practice you want or need (you don't want to have to read half the dictionary to find the meaning of a word: the data needs to be sorted somehow to be useful).

Process areas

The main grouping of the practices is in process areas. These are more or less theoretical groupings of practices in what is a valid and reasonably logical consolidation. Each process area has a well defined purpose, and all the practices that correspond to that purpose are grouped within the area. There are different ways of organizing the practices, which present different sets of advantages and disadvantages. I do not believe that the organization of Process Areas is the perfect solution; I just have not come across one that really convinces me that it is significantly superior. The model tries to cover some of the shortfalls of the approach by including the relationships between the practices and areas throughout the model.

There are twenty-five different areas that are considered in the model, which include process management and improvement areas, team and project management areas, engineering areas, support areas. Each area is defined in a manner that can be used in the measurement of the process capability and the organizational maturity.

Capability levels

The CMMI defines six capability levels. These are differences in the manner a process supports and facilitates the work of the people using them to produce results that will increase customer satisfaction. The capability levels are defined based on two features:

- The manner in which the process is understood and managed throughout the organization;
- Some additional specific practices and their results, built on the outcomes of lesser capabilities activities.

Each process is measured based on the understanding and the results of the process. The first level of satisfaction is that the practices are actually performed and the resulting artefacts exist and can be used. We then move up the scale based on additional features that demonstrate that:

- The practice is understood: the people doing the work have planned to do it, know what needs to be done, what has been done and what were the results of having done it; they have the authority, the responsibility, the resources, the training to do the work; management understands that this is a necessary task and not something that can be dropped without creating additional risks to the project;
- The practice is performed based on what is recognized throughout the organization as being a best practice: the approach is shared between projects and teams, the approach is done according to well defined guidelines and the results of the implementation are used to learn lessons for all other implementations of this practice;
- The practice is statistically predictable: the user understands very rapidly what is the expected outcome, how many defects will be created or removed, the average time needed for this activity. The use of these data allow rapid identification of variations in the implementation of the process, leading to increased predictability in schedule, cost and quality results;
- The practice is being continuously analysed for improvement purposes and everyone who is a stakeholder in this process or the projects that use this process are reviewing the manner in which it fulfils the relevant business objectives of the organization.

The combination of highest-level capabilities of key processes is considered in order to be able to measure the maturity of an organization.

Maturity levels

Maturity levels look at the organization being considered. When considering the maturity of the organization, we are looking at how well the organization as a whole understands its possibilities and limitations. By considering the organization, we need to ensure that some processes are well in place and understood, all of the time, in all teams and projects and that the results are predictable.

Within this context, we consider the maturity level as the consistent implementation across the board of specific practices. This means that the practices need to be supported by management, through policies and controls (measurement, audits...). The processes that are being considered when looking at maturity levels are based on key aspects:

- We start by considering the project management and "discovery" processes, these are the processes in which people in the organization seek to understand what it is they need to achieve and define the manner in which they will achieve this, progress is monitored and measured and basic controls are in place to ensure that the work progresses efficiently and effectively; measurements and systematic controls are implemented in order to see what works best in which circumstances.
- The next level would include sharing of best practices across the board; this includes communication between the teams, projects and management; everyone is applying similar (comparable) practices, allowing lessons learnt to be shared and proposals for improvement to be centralized, developed, communicated and rolled out across the organization.
- As everyone uses the comparable practices and processes, the key processes (or sub-processes), from the point of view of the business objectives, are placed under statistical control in all teams and projects, across the organization - these statistics are then used to ensure that the estimates and plans for any project are based on a clear understanding of the reality and probability of success.
- The highest level of maturity is where the statistics collected are used systematically by everyone in the organization to continuously seek improvement of the productivity and quality of the organization, at every level, always based on the business objectives.

Within the Capability Maturity Modelling approach, each level of maturity has a key word defining it. These key words are Initial (no formal maturity), Managed, Defined, Quantitatively Managed and Optimizing. The change in verb format of the last level (optimizing and not

optimized) demonstrates that this is a continuous approach; the lower, intermediate levels show that the state has been achieved and completed.

The maturity of an organization means that a potential supplier can be relatively confident in the quality of the results and the reliability of a proposal before the work starts. The maturity is largely based on the level to which processes are institutionalised.

Institutionalisation

Institutionalisation means that the process is genetically embedded in the organization. It is part of the way things are done. This does not mean that everyone is working in the same manner, but that no one in the organization would ever consider starting a project without a clear understanding of the estimates, plans for reviews of all key products, etc.

Institutionalisation is therefore based on an expressed, demonstrated and visible commitment from management to ensure that the practices are correctly implemented, and an understanding of all stakeholders as to why this has to be done and what is the impact of doing or not implementing the practice correctly.

Using the CMMI

The CMMI is a model and, like all models, should be considered with appropriate levels of understanding. There is no point in trying to satisfy the CMMI, it is much more important to satisfy your business needs. The CMMI is designed as a measurement tool, allowing you to baseline and prioritise your process capabilities and your organizational maturity with your needs as well as other companies within your business. It also allows for the selection of potential suppliers, based on an understanding of their trustworthiness, at least from a process and practice point of view. This is not sufficient to ensure quality projects and deliveries, but does allow a number of facilities to be in place. The understanding that all the projects have access to the information related to the success of the work they are trying to achieve, and the verification that they are using that knowledge efficiently should at least provide an improved level of consistency in the approach.

Using the model may also identify where the key weaknesses are in the understanding of the practices and success criteria. This is information which can then be efficiently used to plan staged and continuous improvement.

Conclusion

The key to good project management is the efficient use of consolidated knowledge. This knowledge includes information from the project, from the organization, from management, from the team, from the customer, from the suppliers... The management of all the information that a project leader needs to have is critical if it is going to be used productively. Models, such as the CMMI, which offer parallel measurements of capability and maturity, are very useful in ensuring that the organization as a whole and all the people within the organization have access to appropriate levels of information. The model measures their use of that common knowledge, based on the business needs and objectives, and focused on consistency and continuous improvement.

Organizations that seek to implement the model ("doing CMMI") generally end up creating a bureaucracy that does not benefit the company. They end up doing things "because CMMI says so" rather than because they understand the impact of the practice on their business, their customers, their staff. No matter what they implement in this manner, they will always end up demonstrating a fundamental lack of understanding, of knowledge, of maturity.

The Author

With over 30 years experience in the software industry and a dozen years as a professional process improvement facilitator, Peter Leeson is the director and principle consultant for Q:PIT Ltd. He has successfully supported implementations of the CMMI in software and non-software engineering organizations, in small organizations (smallest: 4 engineers) as well as multinationals, throughout Europe (from Ireland to Poland) and the Far East. For more information, see <http://www.qpit.ltd.uk>, <http://www.sei.emu.edu/CMMI>. The author can be contacted at Peter@qpit.ltd.uk.