

Reducing Variation at Each CMMI Maturity Level



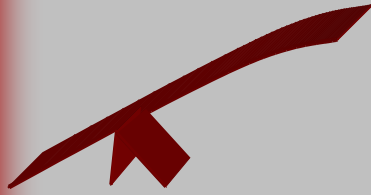
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Welcome

WelKom

Huan Yín

Bienvenido

Bienvenue

Wilkommen

ΚΑΛΟΣ ΟΡΙΣΑΤΕ

Bienvenuto

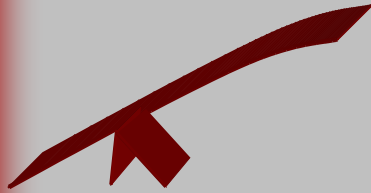
Välkommen

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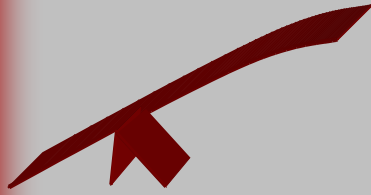
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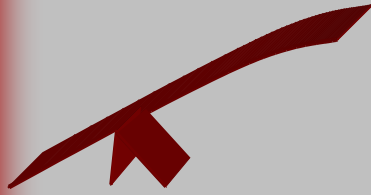
Continuous Variation of Reducing Variation

- ◆ The ideas of variation found in this presentation
 - ◆ Provide the backdrop for using the CMMI model as the basis for an organization's process improvement initiative
 - ◆ Show that this journey is synonymous with **a journey of reducing variation**



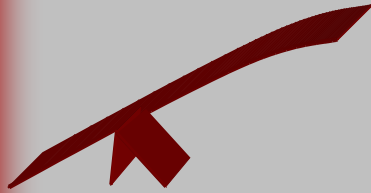
Understanding Variation

Understanding Variation
The Key to Managing Chaos
Donald J. Wheeler, SPC Press, 2000



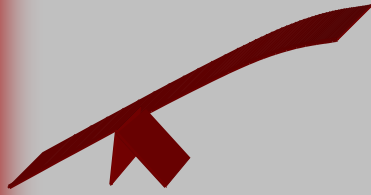
Process Change and Variation

- ◆ Dr. Wheeler shared his interpretation of Dr. Walter Shewhart's approach to interpreting data.
 - ◆ “We analyze numbers in order to know when a change has occurred in our process of system....”
“ ...
 - ◆ Some variation is routine, run-of-the-mill, and is to be expected even when the process has not changed.
 - ◆ Other variation is exceptional, outside the bounds of routine, and therefore to be interpreted as a signal of process change....” “ ...



Understanding Variation

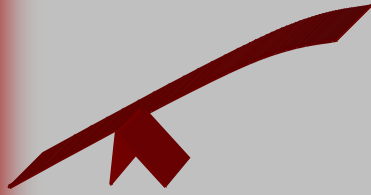
- ◆ Understanding variation is achieved by collecting and analyzing process and product measures so that special causes of variation can be identified and addressed to achieve predictable performance
- ◆ All characteristics of processes and products display variation when measured over time
- ◆ Variation may be due to
 - ◇ Natural or common causes
 - ◇ Special or “assignable” causes of variation
- ◆ Understanding and controlling variation is the essence of CMMI Maturity L4 & L5



Common Causes of Variation

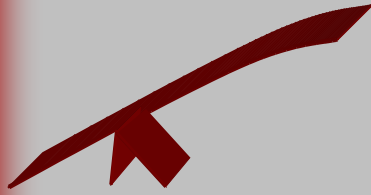
◆ Common causes of variation

- ◆ Variation in process performance due to normal interaction among the process components (people, machines, material, environment, and methods)
- ◆ Characterized by a stable and consistent pattern of measured values over time
- ◆ Variation due to common cause is random but will vary within predictable bounds
- ◆ Unexpected results are extremely rare
- ◆ Predictable is synonymous with in control



Special Causes of Variation

- ◆ Special or Assignable causes of variation
 - ◆ Arise from events that are not part of the normal process
 - ◆ Represent sudden or persistent abnormal changes due to one or more of the process components
 - ◆ inputs to the process
 - ◆ environment
 - ◆ process steps themselves
 - ◆ the way the process steps are executed
 - ◆ **Examples** of assignable causes of variation include inadequately trained people, tool failures, failures to follow the process



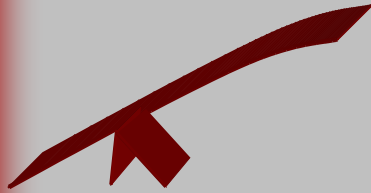
Process Variation

- ◆ Reducing process variation is an important aspect to quantitative management:
 - ◇ It is important to focus on ***subprocesses that can be controlled to achieve a predictable performance***

- ◆ Statistical process control is often better focused on organizational areas such as Product Lines where there is high similarity of processes, than on the organization's entire set of products

CMMI Overview

Level	Process Characteristics	Process Areas																
5 Optimizing	Focus is on quantitative continuous process improvement	Causal Analysis and Resolution Organizational Innovation and Deployment																
4 Quantitatively Managed	Process is measured and controlled	Quantitative Project Management Organizational Process Performance																
3 Defined	Process is characterized for the organization and is proactive	<table border="0"> <tr> <td>Requirements Development</td> <td>Integrated Project Management</td> </tr> <tr> <td>Technical Solution</td> <td>Integrated Teaming</td> </tr> <tr> <td>Product Integration</td> <td>Organizational Environment</td> </tr> <tr> <td>Verification</td> <td>For Integration</td> </tr> <tr> <td>Validation</td> <td>Integrated Supplier Management</td> </tr> <tr> <td>Organizational Process Focus</td> <td>Risk Management</td> </tr> <tr> <td>Organization Process Definition</td> <td>Decision Analysis & Resolution</td> </tr> <tr> <td>Organizational Training</td> <td></td> </tr> </table>	Requirements Development	Integrated Project Management	Technical Solution	Integrated Teaming	Product Integration	Organizational Environment	Verification	For Integration	Validation	Integrated Supplier Management	Organizational Process Focus	Risk Management	Organization Process Definition	Decision Analysis & Resolution	Organizational Training	
Requirements Development	Integrated Project Management																	
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2 Managed	Process is characterized for projects and is often reactive	<table border="0"> <tr> <td>Requirements Management</td> <td>Configuration Management</td> </tr> <tr> <td>Project Planning</td> <td>Measurement and Analysis</td> </tr> <tr> <td>Project Monitoring and Control</td> <td></td> </tr> <tr> <td>Supplier Agreement Management</td> <td></td> </tr> <tr> <td>Product and Process Quality Assurance</td> <td></td> </tr> </table>	Requirements Management	Configuration Management	Project Planning	Measurement and Analysis	Project Monitoring and Control		Supplier Agreement Management		Product and Process Quality Assurance							
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1 Initial	Process is unpredictable, poorly controlled, and reactive																	



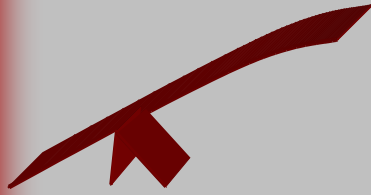
Maturity Level 1: Initial

- ◆ Processes are usually ad hoc and chaotic
- ◆ The organization usually does not provide a stable environment
- ◆ Success depends on the competence and heroics of the people in the organization and not on the use of proven processes
- ◆ Maturity level 1 organizations are characterized by a tendency to over commit, **abandon processes in the time of crisis**, and not be able to repeat their past successes



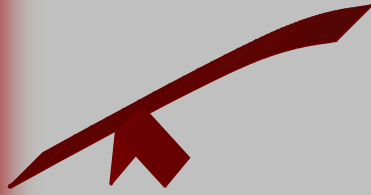
Variation Among Individuals

- ◆ One of the traits of CMMI Maturity Level 1 is that the process “belongs” to the people.”
 - ◇ If others follow a process, it is normally due to the strong personality of someone on the project who has experienced using processes in another environment
- ◆ From a variation point of view, a level one organization has great variation based on its individual employees following their own process paths. This is why maturity level one companies depend so heavily on the heroics of its people



Maturity Level 2: Managed

- ◆ **Projects** ensure that requirements are managed and that **processes are planned, performed, measured, and controlled**
- ◆ The **process discipline** reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress
- ◆ At maturity level 2, requirements, processes, work products, and services are managed
 - ◆ The status of the work products and the delivery of services are visible to management at defined points
 - ◆ The work products and services satisfy their specified requirements, standards, and objectives



Managing the Project Involves

- ◆ Estimating the scope and work that needs to be performed
- ◆ Developing mechanisms to acquire identified products
- ◆ Developing a project plan
- ◆ Getting commitments to the plan
- ◆ Working with suppliers to acquire identified products
- ◆ Monitoring progress against the plan
- ◆ Identifying and analyzing risks
- ◆ Taking action to address significant deviations from the plan
- ◆ Taking action to appropriately mitigate risks



Measurement and Analysis to Support Projects

- ◆ Support projects includes specifying the objectives of measurement and analysis such that they are aligned with established information needs and business objectives
 - ◇ Defining the measures to be used, the data collection process, the storage mechanisms, the analysis processes, the reporting processes, and the feedback processes
 - ◇ Providing objective results that can be used in making business judgments and taking appropriate corrective actions



Basic Measures

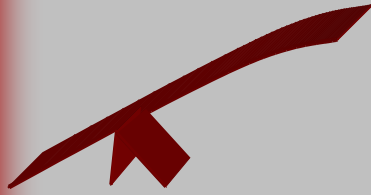
◆ Project Management Measures

- ◆ Size and complexity
- ◆ Effort and Cost
- ◆ Schedule
- ◆ Computer Resources
- ◆ Data Management
- ◆ Knowledge and Skills
- ◆ Stakeholder Involvement
- ◆ Technical Performance
- ◆ Commitments
- ◆ Critical Dependencies
- ◆ Quality



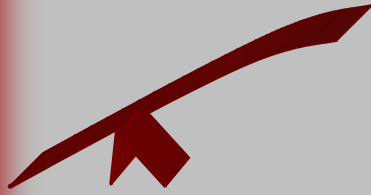
More Advanced Measures

- ◆ Earned value
- ◆ Defect density
- ◆ Peer Review Effectiveness
- ◆ Testing Effectiveness
- ◆ Test Coverage
- ◆ Reliability
- ◆ Maintainability
- ◆ Interoperability



Project's Processes to Reduce Variation

- ◆ At CMMI Maturity Level 2, processes normally belong to the project and are enforced by the Project Manager
- ◆ The processes, standards, guidelines, checklists, and templates are enforced for all of the project members to achieve more uniformity in development and product quality
- ◆ Assuming that all projects follow some form of process, the amount of variation that was seen in organizations of maturity level 1 is reduced even if all of the projects followed a different process



Maturity Level 3: Defined

- ◆ Processes are well characterized and understood, and are described in standards, procedures, tools, and methods
- ◆ The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time.
 - ◇ These standard processes are used to establish consistency across the organization
 - ◇ Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines



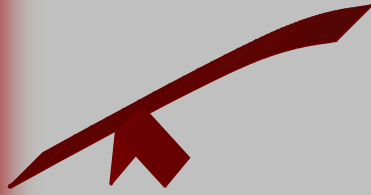
Maturity Level 3: Defined - 2

- ◆ The organization's management establishes process objectives based on the organization's set of standard processes
- ◆ **Processes are typically described in more detail and more rigorously than at maturity level 2**



Organizational Processes to Reduce Variation

- ◆ At The Organizational Level, an organization that wishes to achieve CMMI Maturity Level 3 needs to have its processes owned by the organization for **economy of scale** to be realized and process measurement to make practical sense
- ◆ These process definitions are tailored and incorporated into the **project's defined processes** throughout the organization and thus variation in project development and product and service quality is again reduced



Organizational Processes to Reduce Variation - 2

- ◆ An **organizational measurement repository** is established and maintained which contains both product and process measures based on the organization's set of standard processes along with the information needed to understand and interpret the measures
 - ◆ Trends can be seen and predictability can be start to be achieved
 - ◆ Process performance baselines can now be developed to support quantitative management later

Organization's Process Assets

Measurement
Repository

Life-cycle
Models

Organization's Standard
Processes

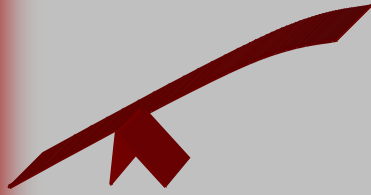
Process
Architecture

Process
Asset
Library

Tailoring
Guidelines

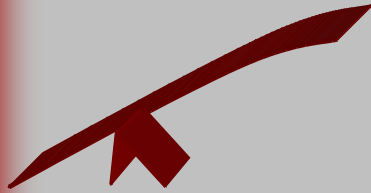
Process
Elements

Support
Environment



Maturity Level 4: Quantitatively Managed

- ◆ Quantitative objectives for quality and process performance are established and used as criteria in managing processes.
- ◆ Quantitative objectives are based on the needs of the customer, end users, organization, and process implementers
 - ◇ Quality and process performance are understood in statistical terms and are managed throughout the life of the processes
 - ◇ Subprocesses are selected that significantly contribute to overall process performance



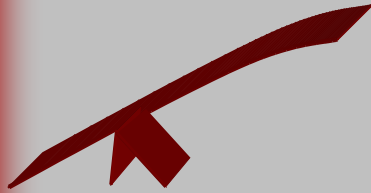
Maturity Level 4: Quantitatively Managed - 2

- ◆ Special causes of process variation are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences
- ◆ Quality and process performance measures are incorporated into the organization's measurement repository to support fact-based decision making in the future
- ◆ The performance of processes is controlled using statistical and other **quantitative techniques**
 - ◇ At maturity level 3, processes are only **qualitatively predictable**.



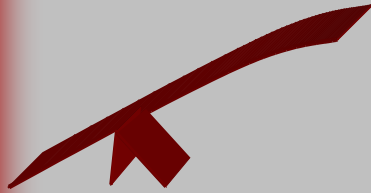
Quantitative Project Management

- ◆ Quantitative Management is tied to the organization's strategic goals for product quality, service quality, and process performance
- ◆ When higher degrees of quality and performance are demanded, the organization and projects must determine if they have the ability to improve the necessary processes to satisfy the increased demands
- ◆ Achieving the necessary quality and process performance objectives requires stabilizing the processes or subprocesses that contribute most to the achievement of the objectives and reducing process variation to support the quantitative management objectives.



Process and Product Performance

- ◆ Process performance is a measure of the actual process results achieved
- ◆ Process performance is characterized by both process measures and product measures
- ◆ Process measures include:
 - ◆ Effort
 - ◆ Cycle time
 - ◆ Defect removal efficiency
- ◆ Product measures include:
 - ◆ Reliability
 - ◆ Defect density
 - ◆ Response time



Moving from Defined Processes to Quantitatively Managed Processes

- ◆ With **defined processes**, measures are collected and analyzed to understand and manage activities and results:
 - ◇ Threshold limits are set, but not using statistical and other quantitative methods
 - ◇ Exceeding threshold limits triggers actions
- ◆ **With quantitative management**
 - ◇ Analyses are concerned with addressing special causes of process variation
 - ◇ Measurements are analyzed quantitatively to
 - ◆ Understand process performance
 - ◆ Predict the achievement of product quality and service quality objectives



Quantitative Tools

- ◆ There are a number of quantitative tools considered to be applicable to statistical process or quality control:
 - ◇ Quantifying and Predicting Process Performance
 - ◆ Control Charts
 - ◆ Histograms
 - ◆ Run charts
 - ◇ Cause and Effect Relationships
 - ◆ Scatter diagrams
 - ◆ Cause-and-effect (fishbone) diagrams
 - ◆ Bar charts
 - ◆ Pareto charts
 - ◆ Interrelationship Diagram
 - ◆ Kiviat Diagram

PROCESS CONTROL CHART TYPE:

METRIC:

Upper Control Limit (UCL)

A point above or below the control lines suggests that the measurement has a special preventable or removable cause

The chart is used for continuous and time control of the process and prevention of causes

Center Line (CL)
(Mean of data used to set up the chart)

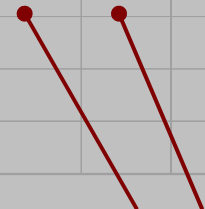
The chart is analyzed using standard Rules to define the control status of the process

Upper and Lower Control Limits represent the natural variation in the process

Plotted points are either individual measurements or the means of small groups of measurements

Lower Control Limit (LCL)

Data relating to the process



Numerical data taken in time sequence

Statistical Methods for Software Quality
Adrian Burr – Mal Owen, 1996

Histogram

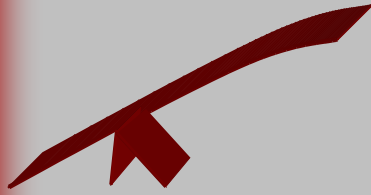




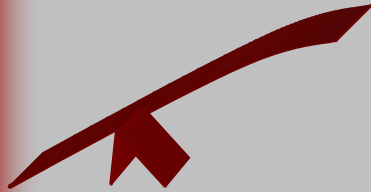
Quantitative Project Management Concepts

References

- ◆ Some sources that can help to really understand what is behind this statistical process control are:
 - ◆ Understanding Variation by Donald Wheeler
 - ◆ Statistical Methods for Software Quality by Adrian Burr and Mal Owen
 - ◆ Measuring the Software Process by William Florac and Anita Carleton.



Voice of the Customer



Process Capability

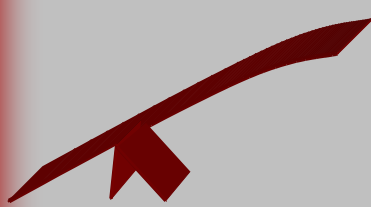
- ◆ Process capability is analyzed for those **subprocesses** and those measured attributes for which objectives have been set
- ◆ A capable process is one that is satisfying its quality and process performance objectives and can be expected to satisfy those objectives in the future



Voice of the Process

◆ Voice of the Process

- ◆ The natural bounds and variation within those bounds of process performance
 - ◆ variation is within 3σ of the process mean
 - ◆ process is stable and does not exhibit any unlikely patterns or events

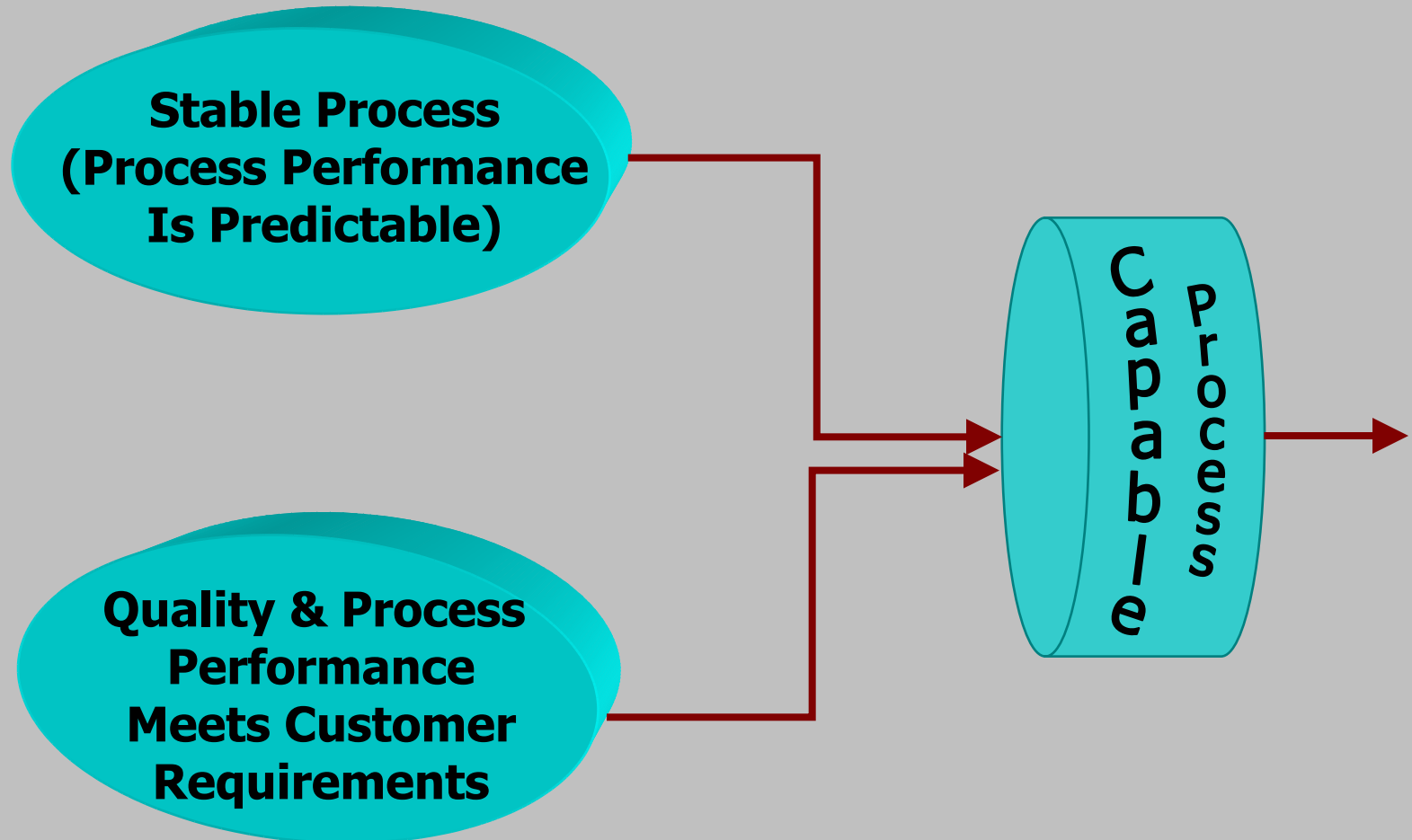


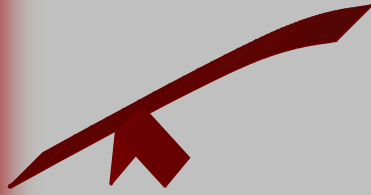
Voice of the Customer

◆ Voice of the Customer

- ◆ The goals established for the product and process performance
 - ◆ product specifications
 - amount of downtime
 - mean time to failure
 - response time
 - ◆ management specifications
 - meeting the schedule
 - meeting the budget

Capable Processes





Summary

Process Capability Prediction

Level	Process Characteristics	Predicted Performance
5 Optimizing	Focus is on continuous quantitative improvement	
4 Quantitatively Managed	Process is measured and controlled	
3 Defined	Process is characterized for the organization and is proactive	
2 Managed	Process is characterized for projects and is often reactive	
1 Initial	Process is unpredictable, poorly controlled, and reactive	



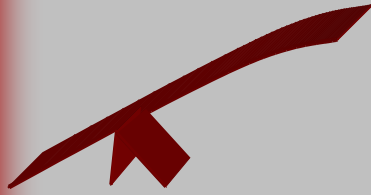
Summary

- ◆ The Process Capability Prediction figure provides a “process capability prediction” view of the CMMI and illustrates the theme of reduction of variation
- ◆ **Initial** level - target dates of cost, schedule, performance and quality are often missed by wide variation.
- ◆ **Managed** level - the variability of the actual results around the target decreases.
- ◆ **Defined** level - variability again decreases.
 - ◇ Target hits increase and the
 - ◇ Target begins to move in toward the Y-axis due to reduced rework.
- ◆ **Quantitatively Managed** level - variability continues to decrease.
 - ◇ Target results improve,
 - ◇ Development time becomes shorter
 - ◇ Productivity and quality increase.
- ◆ **Optimizing** level - defect prevention helps to reduce rework further and variation continues to be reduced.



Summary - 2

- ◆ There are also many different ways that the CMMI can help an organization that are not always obvious on the surface
- ◆ *Helping an organization to reduce variation as it improves in its process capability is a benefit of using the CMMI that all organizations should strive to utilize*



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