BaiGuo ML4 Journey

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Pamelia Rost – EVP Business Development Kasse Initiatives

How a focus on high maturity CMMI-based process improvement can add value to the organization even when there are only limited resources

Presentation Topics

- BAI GUO Background and Culture
- BAI GUO Process Improvement Methodology
- GQ(I)M method used to align business goals to indicators and metrics
- Data Analysis Interpretation
- Developing and Evolving the Prediction Model
- Project Managers and Quantitative Project Management
- QPM Story
- Summary of Six Sigma Techniques Used
- Lessons Learned

BAI GUO Background and Culture

Sponsorship for CMMI-DEV Class A ML 4 Appraisal

BAI GUO Background

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- BaiGuo Info-Tech Co. Ltd is a high-tech enterprise professional on automation of health care in Shanghai
- 30% of leading staff in R&D department have been working on medicine information industry and long-distance info processing industry for more than 10 years in America
- International advanced CMMI quality management model was chosen to be applied to assure high quality products and services

Culture

- Senior Management and other key members of the organization had a CMMI-based process improvement background from other companies before they formed or joined BAI GUO
- A culture of "sharing" and supporting colleagues is pervasive and supported by Senior Management
- Peer Reviews are a key process component of all projects
  - While the "peer" part of the reviews is honored anyone who has the necessary expertise, including the senior management participates in the peer reviews and truly acts as a "peer" during those sessions.
  - The focus of these peer reviews is to improve the product and processes that were followed to create that product
- Project Leaders are not only asked to manage their projects but to look at their project and other projects from an organizational point of view

Culture - 2

- CMMI ML3 thinking and actions are considered the minimum required for BAI GUO to control costs and manage risks
- High Maturity is seen to be the necessary component to increase the control and accuracy of Management decision making
- All Project Managers are aware of and can share / teach the Organization's Set of Standard Processes to other managers and employees
- EPG Lead not only promotes the Organization's Set of Standard Processes but also serves as BAI GUO's Measurement Lead

Initial readiness check

- How ready is the organization for starting the ML4 journey?
- On-site check, using a predefined HM checklist, before taking up the project:
  - Meet the senior management, EPG, project leaders, and their measurement group (if it exists)
  - Who will analyze the data? Experience?
  - Capability of the project leaders to interpret the analysis results for managing their projects
  - Questions covering:
    - Vision, business objectives
    - Process: solid ML3 foundation ?
    - Measurement repository, measurement system, tools ?
    - Stable processes?
    - PPB , PPM

Vision

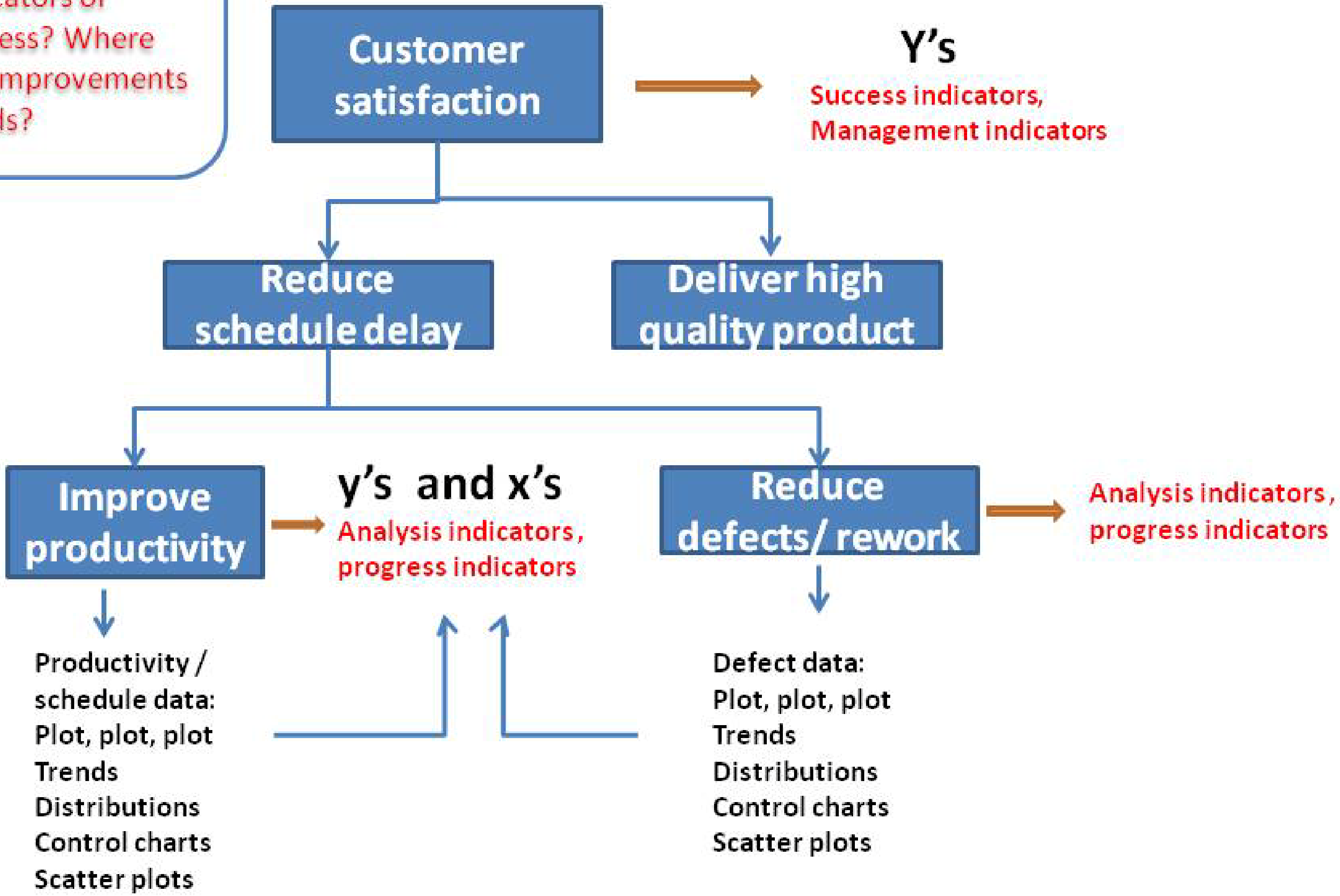
- Improve customer satisfaction
- Obtain more repeat orders.
- Increase company size to 100 in 3 years, and
- IPO in 2015.

Business Objectives

- Improve the Customer Satisfaction by:
  - Improving schedule performance (reduce delivery delays)
  - Improving the quality of the delivered product
- Improve the development work by:
  - Controlling or reducing project costs
  - Improving the productivity

Project: what are leading in-process indicators of success? Where are improvements needs?

Business Objectives



Quantitative Objectives

Derived quantitative objectives:

By **12/31/2010** our organization will improve **Productivity (FP/man-hr)**

from today's performance baseline of:

Mean = 0.26 Std. Dev =0.08

to a new performance baseline of:

Mean = 0.28 Std. Dev =0.06

with at least **95%** of confidence.

without sacrificing the product quality:

Quantitative Objectives - 2

Derived quantitative objectives:

By **12/31/2010** our organization will improve **Defect Density (Defects/FP)**

from today's performance baseline of:

Mean = 0.46 Std. Dev =0.2

to a new performance baseline of:

Mean = 0.43 Std. Dev =0.18

with at least **95%** of confidence.

Project delivery time is closely related to the staff productivity and the amount of defects / rework (quality). In Baiguo , it is believed that if productivity and quality are in control, the delivery is also in control.

The Appraisal Team

BAI GUO Process Improvement Methodology

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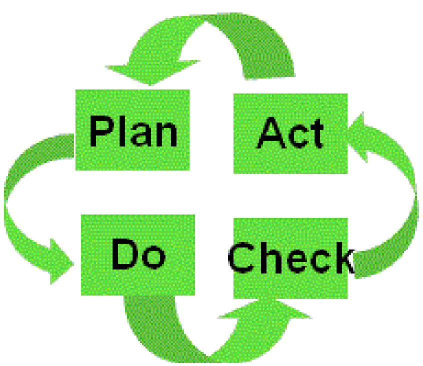
Problem and goal statement (Y)

Define → Measure → Analyze → Improve → Control

- Clarify
  Business Goals
- Process maps
- Prioritize issues

- Define measures
- Collect & verify measures

- **Discovery**: plots, paretos, histograms, distributions, fishbone
- **Understanding**: root cause, critical factors
- **Performance**: Process stable?
  Process capable?
- Corrective actions to **Improve** Process



Y=f(method, review rate, experience .....)

High Maturity Improvement Cycle

- Duration of an improvement cycle depends on:
  - Project cycle / duration
  - Number of projects per year
  - Quality of project measurement data
  - How long it takes to deploy a change
- Each improvement cycle is around 3 months in BaiGuo
- **Key points** to consider in preparing for appraisal:
  - Any statistics specialist in the team to analyze the data (Project leaders / EPG should be able to **INTERPRET** the data)
  - For the HM PA, evidences should be prepared to the subpractice level
  - Use a Q&A at SP/GP level to set the appraisal expectation to the organization

6 Sigma techniques used – an overview

Define	Measure	Analyze	Improve	Control
Voice of Customer	**Metrics: defects, project mgmt**	**Regression**	Design of Experiments	Statistical Controls
Voice of Business	Data Collection Methods	**Cause & Effect**	**Modeling**	**Control Charts**
Project Charter	Sampling Techniques	Diagrams , Matrix	Eliminate waste	Time Series methods
Kano model	Measurement System Evaluation	**Failure Model Effects Analysis FMEA**	Robust Design	Other control tools
QFD	Quality of Data	7 Basic Tools	Kaizan	Sustain improvement
Process Flow Map		**Hypothesis Tests**	Decision & Risk Analysis	Procedural adherence
"Management by Fact"		Root Cause Analysis		
		Reliability Analysis		

Measurement and Analysis

Measurement and Analysis Highlights

- Descriptive statistics are provided to show mean and standard deviation for Productivity and Total Defects
- Statistical techniques used through MiniTab and Crystal Ball include:
  - Scatter Plots to determine correlation between Requirements elicitation and size in Function Points and Design and size in Function Points and CUT and size
  - Regression Analysis was used for Requirements elicitation and size, Design, and Code and Unit Test
  - Analysis of Variance was run to determine statistical significance
  - Stepwise regression was run for Requirements Elicitation, Design, and CUT vs. Size FP vs. Team Experience vs. Requirements Volatility

Measurement and Analysis Highlights - 2

- A linear regression relationship was able to be built between Requirements elicitation effort and the size:
  - A similar regression relationship was built for Coding and Size
  - For the design effort it was found that Team Experience is also a factor in addition to size (in FP) for predicting the design effort.
  - Scatterplots, Regression Analysis and Stepwise regression were also applied to Reviews
    - Regression Analysis: Prep versus Reviewed Size
    - Regression Analysis: Conduct Review versus Reviewed Size
- Boxplots and ANOVA were applied to Preparation Time + Conduct Review time versus Review Type

Regression analysis – an example

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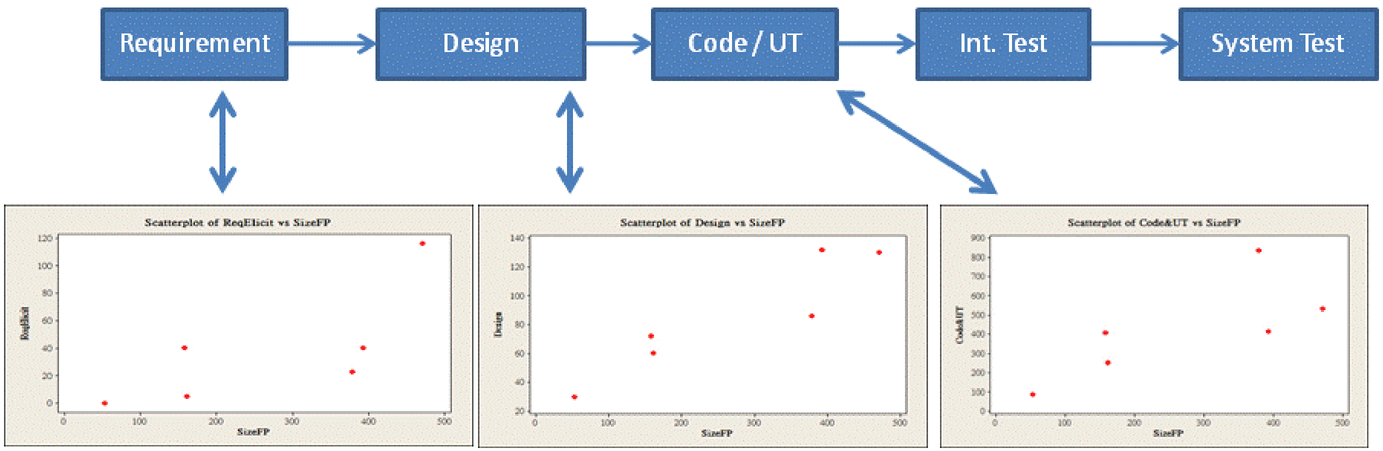


1. *Relationship of Requirement, Design, Coding to Size (FP)?*
2. *Regression analysis:*

   Design [Y] = 24.8 + 0.224 x Size (FP)
   P=0.008 significant

3. *Effect of independent factors, such as team experience, reuse, requirement volatility ?*

   Design = f(team experience, size)
   R^2 (adj.) = 92% , P=0.007 significant

Software Development Process Map and Measures

Organizational Process Performance

Organizational Process Performance Highlights

- **Establish Quality and Process-Performance Objectives**
  - Quantitative Measurement Objectives for Quality and Process Performance are documented in BAI GUO Organization Strategy document
  - SMART Objectives were used to define the Quantitative Measurement Objectives
  - ***BAI GUO is in the Medical Hospital Industry and has built IT systems to transfer patient records from remote farming areas to nearest Hospitals and from Hospitals to Hospitals in bigger cities. Time to market and quality are crucial.***
- GQM approach is used to determine the measures for each objective

Organizational Process Performance Highlights - 2

- The definitions of all the required measures are documented in the metrics definition guideline – BAI GUO Metrics Definition Guideline
  - Name of metric
  - Business objective
  - Unit of measure
  - Formula
  - Source of data
  - Frequency of collection
  - Where the data is stored
  - Owner of the data
  - Tool used to collect basic measures (automatic collection for basic measures)
  - Collecting requirements to ensure data validation
  - Recommended statistical technique

Organizational Process Performance Highlights - 3

- A Table of Basic measures with their units of measure has been created and is part of the Metrics Definition Guideline
  - Significant time was put in to define what basic measures were needed along with their units of measure

Organizational Process Performance Highlights - 4

- **Select Processes -** Approach taken in BAI GUO
  - Looked at all the available historic data, by project phase
  - Tried to validate the data by scatter plot, and calculate the summary statistics (mean, standard deviation) to see if the data were reasonable
  - Correlation was used to see what factors affected the effort and build the regression relationship between the outcomes and the factors
  - Steps were repeated by decomposing the subprocesses. Again correlation was used to see what factors affected the effort and the regression relationship was built
  - Preliminary findings were validated with the consumers (Project Leaders) to ensure the model and analysis made sense

Organizational Process Performance Highlights - 5

- **Total Defects Segmentation**
- Opportunities for Improvement were identified
  - Improve development work
  - Improve productivity
  - Reduce rework and Cost of Quality to improve overall productivity (Total Rework and rework per defect)
  - Defects from each lifecycle phase were examined
  - Defect Data was collected from multiple small projects

Organizational Process Performance Highlights - 6

- **Defects were broken down by A, B, and C defect categories** with full explanation behind them in the Testing Process document
  - A - Serious
  - B – Major
  - C – Minor
- Systems Testing produced the most defects → Upstream activities were examined
- **Pareto Charts of A, B, and C categories of** defects that contributed to rework were developed by lifecycle phase

Organizational Process Performance Highlights - 7

- **FMEA** was conducted to further categorize the CAT B defects per lifecycle phase and reduce the defects coming into and going out of Systems Test
  - Invite all project leaders, and EPG; Delphi Method were used
  - FMEA Table included:
    - Potential Failure Mode
    - Potential Failure Effects
    - Severity (1-10)
    - Potential causes
    - % of Occurrence (1-10)
    - Current Control
    - % of detection (1-10)
    - RPN = Severity x Occurrence x Detection

Process Step	Potential Failure Mode (from checklist)	Potential Failure Effects	SEV (1-10)	Potential Cause	OCC (1-10)	Current Controls	DET (1-10)	R P N	Actions Recommended	Responsibility	Action Taken
Require-ment	Contradicting/ repeated requirements		8		7		4	**224**			
	Non-functional requirements not clear		8		8		3	**192**			
	Others		6		8		3	**144**			
Design	Incomplete, not testable		7		6		4	**168**			
	Design not traceable to requirement		5		7		4	**140**			
	Not match interface spec		8		6		3	**144**			
	Others		8		4		4	**128**			
Coding	Module too complicated / complex		6		5		6	**180**			
	Did not avoid floating point operation		7		5		5	**175**			
	Loop, branch, logic not correct		7		5		6	**210**			
	No check for input parameters		7		6		6	**252**			
	Others		6		7		5	**210**			

Purpose: The purpose is to reduce the rework effort in project, to find out the defect source from review checklist which impacts rework effort most.
Here lists the checklist items which impact the defect most.

Organizational Process Performance Highlights - 8

- Highest priority areas were examined as input and a Cost-Tradeoff Analysis was conducted
- Defects coming out of Coding were focused on first as the most practical and cost effective area to concentrate on
  - Upgraded Code Review guidelines were developed with enhanced guidelines which emphasized lower level categories from Coding
- If results from the focus on Coding were not sufficient, the next alternative solution was discussed with Senior Management to determine feasibility

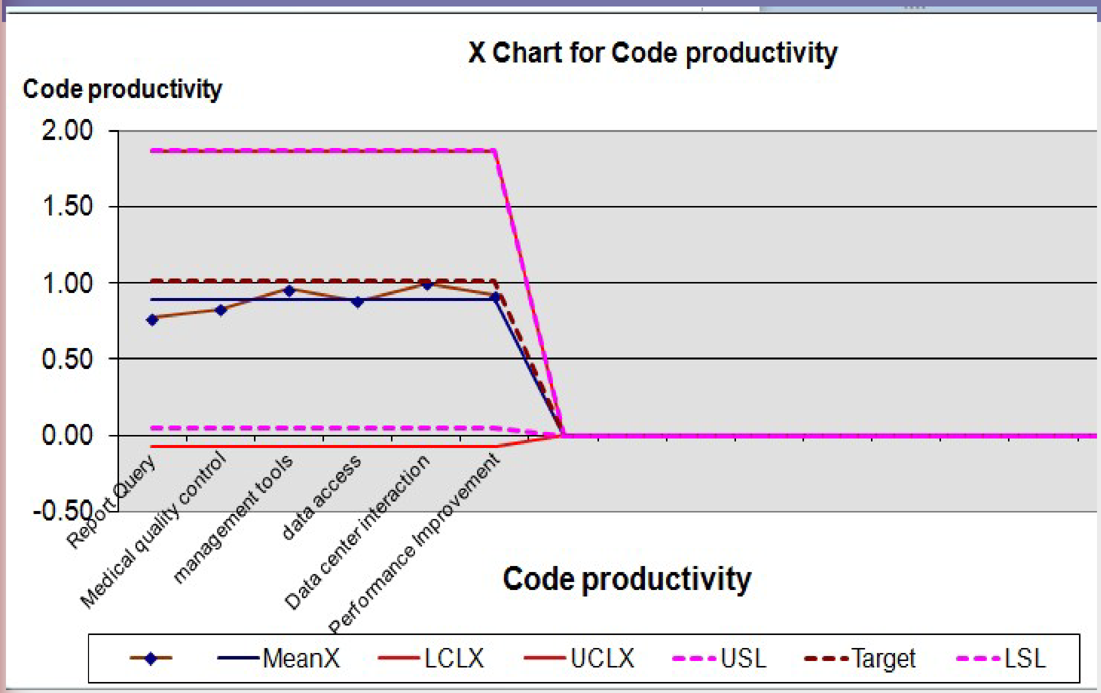
Organizational Process Performance Highlights - 9

- **Subprocess Selection Guideline**
- Developed to support the traceability of subprocesses back to Business Objectives and vice versa
  - Business Goal
  - Goal type
  - Stakeholder Perspective
  - Typical Questions
  - Metrics
  - Impacting Sub-processes
  - Sub-process control measure

Organizational Process Performance Highlights - 10

- **Statistical Control (Stable Processes)**
- XmR control charts are used for Requirements and Coding to ensure productivity is statistically managed
  - EXAMPLE: A spike in productivity was noticed. Causal analysis was conducted. It was determined that there was a high use of “re-use” at that point. However, it was decided that this was an anomaly and the control limits were not changed

Control chart - example



Process Stability	Process Capability	Cpk	Cpm
Stable	Capable	3.25	2.11

Organizational Process Performance Highlights - 11

- **Process Performance Baselines (PPBs)**
- The organization’s Process Performance Baselines (PPBs) were derived through analyzing the distribution of the data to establish the central tendency and dispersion (sigma) to characterize the expected performance and variation for the selected processes or subprocesses.
  - EPG provides templates to Project Teams and provides training on their use
  - Project Teams collect required data and give it to the EPG - automated
  - Training was also provided on how to interpret the Excel or Minitab analysis results based on historic data

Organizational Process Performance Highlights - 12

- The PPB and related measurements are reviewed regularly in the EPG meetings (by the EPG group and the PMs), in the project meetings (by PMs and project team members), and the senior management meetings (by GM, EPG, QA, PMs).
- PPB Summary Report
  - Processes
  - Subprocesses
  - XmR Charts for productivity
- PPBs are updated every six months – ANOVA is used to determine statistical significance of productivity change

Organizational Process Performance Highlights - 13

- **Process Performance Models (PPMs)**
- There is a Crystal Ball predictive model for productivity and quality.
- Besides the crystal ball, there are also other PPMs (e.g. linear regression) for Project Leaders to reference to.
  - E.g. relating the upstream process factors to predict the activities downstream in the Minitab.

Crystal Ball prediction model – an example

		Prototyping				Std Interview				
Requirements Elicitation		LL	Avg	UL		LL	Avg	UL		LL
	Effort	48	66	84		37	55	73		50
	ycle Time	15	20	25		30	35	40		30
	Quality	0	18	37		0	23	46		0
		PeerReview(Low)				**ExpertReview(Low)**				**Pee**
Reqts Review		LL	Avg	UL		LL	Avg	UL		LL
	Effort	26.128	26.368	26.608		11.806	11.926	12.046		28.452
	ycle Time	1	2	3		1	4	7		1
	Quality	82.00%	95.00%	98.00%		97.00%	93.00%	99.00%		82.00%
		SA / SD				**Hig Exp SA / SD**				
Design		LL	Avg	UL		LL	Avg	UL		
	Effort	43.748	68.948	94.148		24.252	49.452	74.652		
	ycle Time	40	45	50		50	55	60		
	Quality	0	9.96	19.92		0	9.13	18.26		
		PeerReview(Low)				**ExpertReview(Low)**				**Pee**
Design		LL	Avg	UL		LL	Avg	UL		LL

Integrated Project Management

Integrated Project Management Highlights

- Project Closure meeting is held at end of each project to capture
  - Project size and effort tracking results
  - Actual work effort for each phase
  - Deviation of effort/schedule for every milestone
  - Measurements to update PPBs
  - Sent to EPG Lead for consideration to be included in the Organization's Measurement Repository or Process Asset Library

Project Monitoring and Control – Highlights

- Actuals to estimates tracked include:
  - Size, Effort, Risks, Stakeholder Involvement, Resources, Quality, Non-compliances
- Schedule Variance is calculated and acts as a threshold for corrective action
- Cost Variance is calculated and acts as a threshold for corrective action
- XmR Control Charts are used to ensure process stability – Special Causes of Variation are analyzed and corrected
- At the end of each Milestone, Crystal Ball is run using last phase's data to predict next phase results (Interim targets) and all subsequent phases

Quantitative Project Management

Quantitative Project Management Highlights

- Projects make use of Organizational selection of processes and subprocesses created from OPP
- Project Managers conduct an analysis of data in the PPB to determine which subprocesses will contribute most to meeting the measurement objectives of the project. These are placed into the Project Quantitative Management Plan
- Crystal Ball model was also rerun after each phase (e.g. req ph) milestone to predict the outcome from the downstream processes.

Quantitative Project Management Highlights - 2

- Subprocesses with the most variation were selected - Requirements, and Coding+UT.
  - Other subprocesses are less affected, and have less variation.
  - E.g. defects at the requirement phase will affect the defects and rework in the testing phase.
- Similar to OPP, analysis was carried out on various factors to determine the critical subprocesses
- XmR charts were used on past project data to show that the productivity of those subproceses were stable

Quantitative Project Management Highlights - 3

- At the end of each phase the control chart was used to show if the selected subprocess are meeting the specification
- Cpk was calculated to see that the degree of meeting the customer specification limits are met
- Crystal Ball was used to recalculate confidence level for to predict meeting the overall project goals at the end of each phase

Quantitative Project Management Highlights - 4

- The definitions of the common measures, units are found in the organizational guideline BG Metrics Definition Guideline
- The USL and LSL of the objectives of the critical subprocesses were specified in the Project Performance Measurement Plan
  - These USL/LSL are compared with the model and the baseline figures in a summary table
  - The correctness of these USL/LSL of selected critical subprocesses are reviewed
- Statistical techniques used include: XmR charts, u-chart, confidence interval, and Pareto charts for the defects by category

Quantitative Project Management Highlights - 5

- The Project Performance Measurement Plan contains the description of the 'responsibilities', 'by/to whom', 'how often', 'data storage', 'analysis'
  - Quality objective
  - Priority
  - Metric – Unit of Measure
  - Target
  - USL – Upper Specification Limit
  - LSL – Lower Specification Limit
  - Reason for Target
  - PPM used
  - Remarks

Quantitative Project Management Highlights - 6

- **Operational Definitions** found in the **Metrics Definition Guideline [See OPP Sp 1.3]**
  - Name of metric
  - Business objective
  - Unit of measure
  - Formula
  - Source of data
  - Frequency of collection
  - Where the data is stored
  - Owner of the data
  - Tool used to collect basic measures (automatic collection for basic measures)
  - Collecting requirements to ensure data validation
  - Recommended statistical technique

Quantitative Project Management Highlights - 7

- Data was collected at Project Closure and presented to EPG
- PPBs were updated by EPG Lead as appropriate
- Metrics Definition Guideline was updated as appropriate

Summary and Lessons Learned

- **Look before you jump** – a thorough initial readiness check before starting the high maturity journey
- **Upfront high maturity training** to the process champions so that they, who understand the strengths and weaknesses of the current processes, can drive the SPI
- **Periodic assessment** – a knowledgeable Appraisal Team, mostly from the organization, can also direct the organization towards the right direction
- **Talk, talk, talk** – the measurement team and the external consultant(s) should communicate with the project managers periodically to validate the measurement findings; the Project managers are always the people best equipped to 'interpret' the analysis findings

Processis

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- **President & Principal Consultant of Processis Ltd.**
- Edmond has more than 25 years of experience in the information technology and related service industry
- Edmond's current focus is to assist companies to improve their processes, products and service quality using an effective combination of CMMI and Six Sigma.
- Edmond has more than eight years of experience in CMMI-based training / consulting/ and appraisal services.

Tim Kasse

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- Visiting Scientist - Software Engineering Institute
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- Author of Action Focused Assessment for Software Process Improvement
- Author of Practical Insight Into CMMI

Practical Insight Into CMMI – 2nd Edition (Sept 2008)

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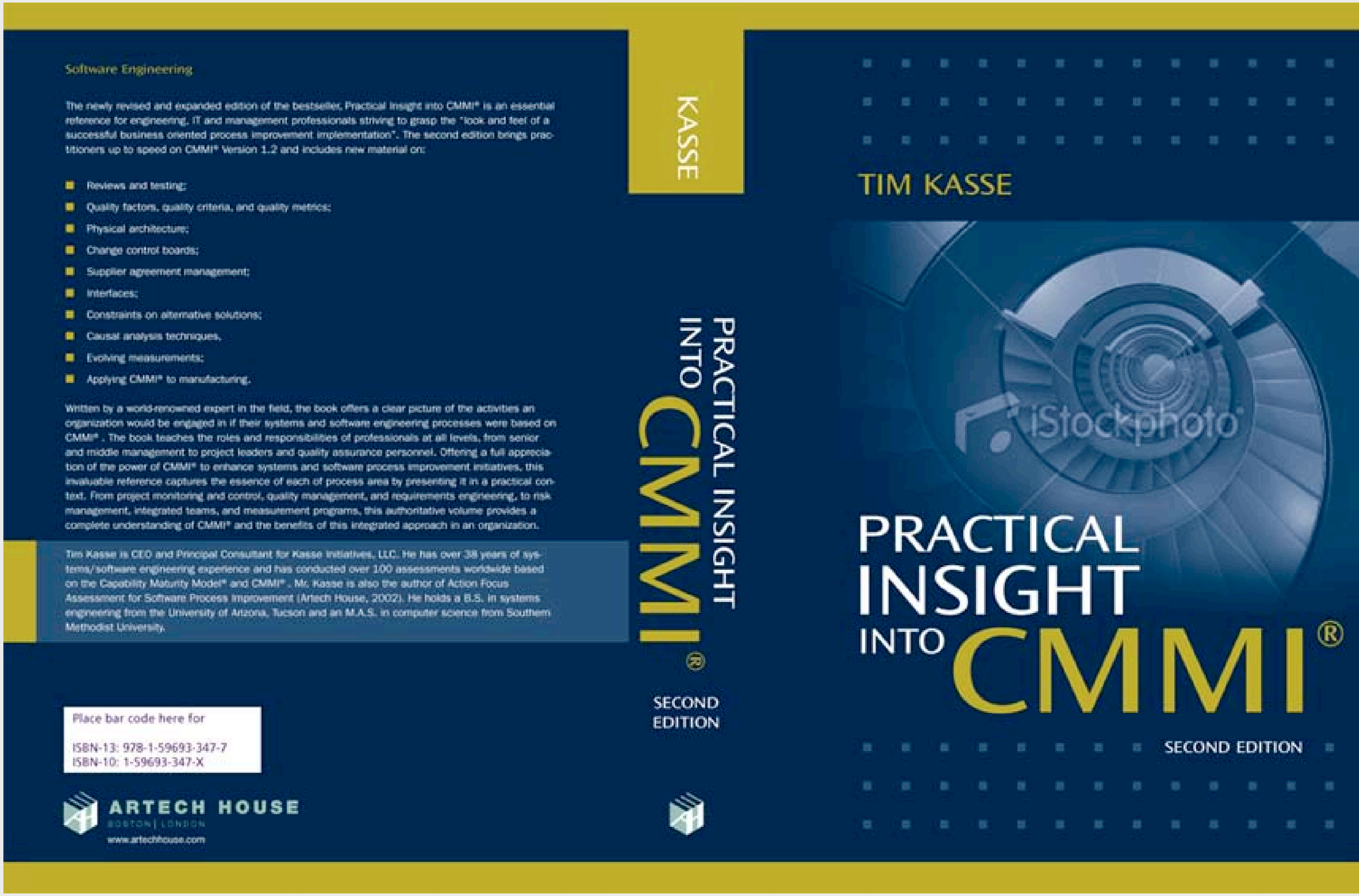

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