CMMI Bottoms-Up Assessment: a Grounded Analysis from the Perspective of Practicing Engineers in Defense Engineering

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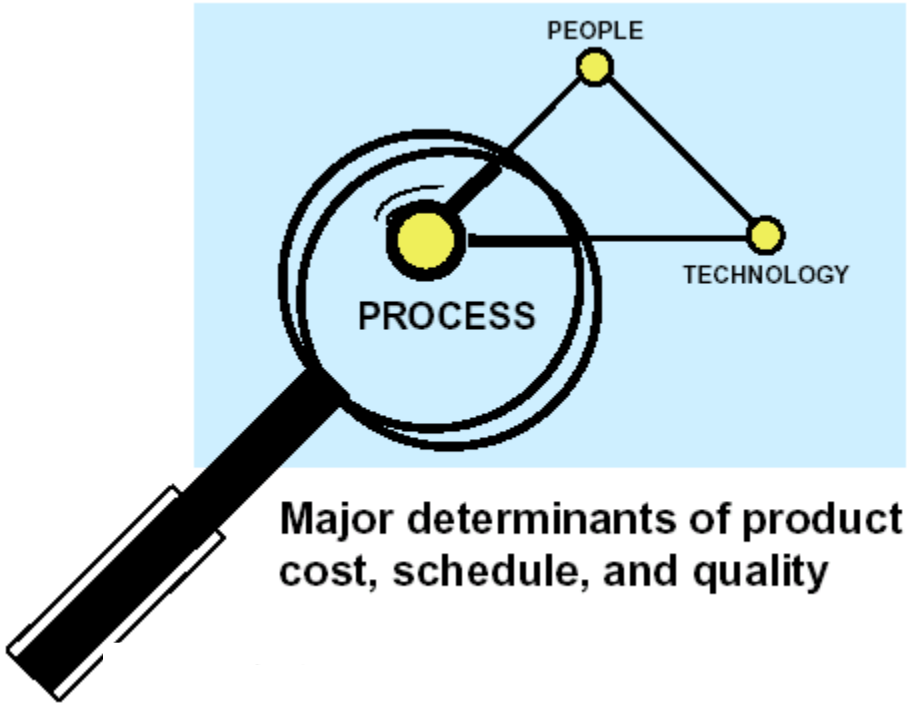
Presentation Topics

- **Quality Leverage Points Trilogy: Process, People, & Technology**
- **Social Theories Applied to CMMI: Marx, Taylor, & Weber**
- **CMMI Bottoms-Up Assessment: a Grounded Analysis from the Perspective of Practicing Engineers in Defense Engineering**
- **CMMI Case Study Conclusions & Recommendations**

Quality Leverage Points Trilogy: Process, People, Technology

Everyone realizes the importance of having a motivated, quality work force but...



Major determinants of product cost, schedule, and quality

...even our finest people can't perform at their best when the process is not understood or operating "at its best."

←Process, People, Technology

Source: SEI CMMI V1.2

What About People?

- **According to Watts Humphrey:**
  - "Talented people are the most important element in any software organization."
  - "The better and more experienced they are, the better the chance of producing first-class results….First-class people are essential, but they need the support of an orderly process to do first-class work."
- **What Can We Learn about People from Social Theories?**

Social Theories Applied to the CMMI

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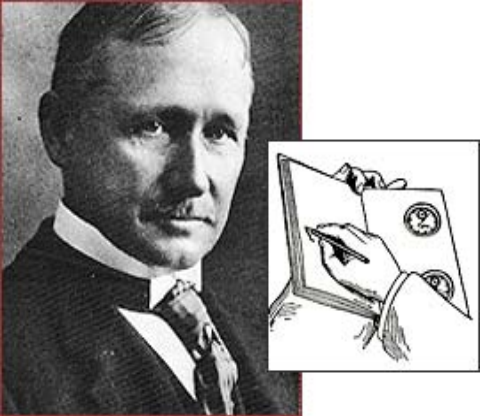
CMMI as Contemporary Iron Cage: a Grounded Analysis from the Perspective of Practicing Engineers in Defense Engineering. St. Paul, MN: University of St. Thomas doctoral dissertation.

Conflict Theory – Karl Marx

- **Worker Alienation [*Manuscripts of 1844]:***
  - "The boss imposes the kind of work, the method and the rhythm, but never bothers if the worker ends up as: a mere appendage of flesh on a machine of iron."
  - "The deepest essence of man, his creative act, has been transformed into a possession."
  - "Alienation not only degrades man, but also depersonalises him."

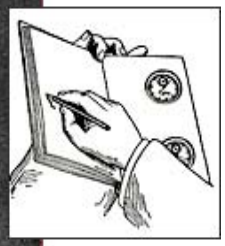
Conflict Theory – Marxian CMMI Implications

- **Companies** have established Mandatory Policies, Procedures, & Work Instructions to comply with the CMMI that Rigidly Control Engineering Processes & Product Development
  - "The boss imposes the kind of work, the method, and the rhythm …"
- **Management** has usurped Engineering Creativity
  - "The deepest essence of man, his creative act, has been transformed into a possession."



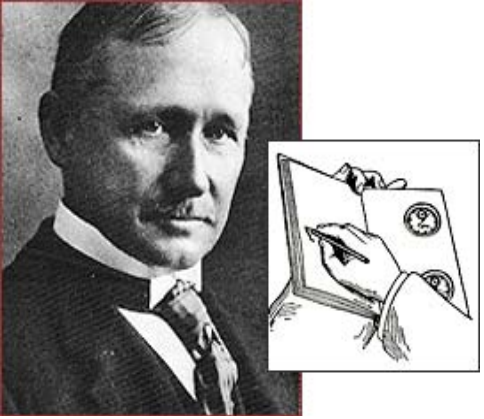
Frederick Winslow Taylor's Scientific Management

- **Introduced many of the Alienation Methods that Karl Marx Warned about:**
  - **Pushed the Division of Labor to the Extreme**
    - Decomposed the work process into fragmented assembly line tasks that separated the mental concept of product creation from the physical act of product creation
    - Claimed the mental act of creation for management & relegated the physical act of production to the worker
    - Management usurped the master craftsmen's knowledge, documented it, codified it via work sheets for unskilled workers to follow, & eliminated the master craftsmen



Frederick Winslow Taylor's Scientific Management

- **Used Scientific Management Principles to Maximize Management Control of the Worker's Thinking, Acting, & Doing:**
  - Management seized total Control of the Manufacturing Processes, Methods of Product Production, & Workers Mental and Physical Movements
  - Dehumanized, Deskilled and Robotized Workers, which Alienated them from their Work Product, their fellow Workers, & their Families
  - Used Foremen and Industrial & Quality Control Engineers as Work Process Cops – forcing the Workers to blindly follow Scripted Processes, Methods, & Task Sheets



Frederick Winslow Taylor's Scientific Management - CMMI Implications

- **Division of Labor** has basically occurred in accordance with the CMMI's 22 Process Areas
- **Management Control** of the Engineer's Thinking, Acting and Doing has been achieved via mandatory CMMI driven Policies, Procedures, & Work Instructions
- **Compliance Verified** via: Internal Audits, Process Audits, QA & CM Audits, & CMMI Appraisals

Max Weber's Conflict Theory

- **Bureaucratization of Organizations:**
  - **Provided Management** with an Organizational Methodology that aids Decision Making & Maximizes 4 Factors of Business Operation:
    - **Efficiency** – achieved using optimal means (tasks, methods, & processes) to attain desired ends (products)
    - **Calculability** – achieved using quantification of inputs, processes, outputs, resources, & finances
    - **Predictability** – achieved using consistent, uniform production methods & processes
    - **Control** – achieved tightly controlled automated dehumanized processes, feedback systems, & monitoring of work performance

Max Weber's Conflict Theory – CMMI Implications

- **SEI & DoD** have confirmed CMMI Assessed Companies Achievement of Weber's 4 Factors of Business Operation & Performance:
  - Greater Efficiency, Calculability, Predictability, & Control
- However, Bureaucratization Impacts (Iron Cage) on Engineers largely Ignored:
  - Job Satisfaction & Job Performance?
  - Loss of Incentive & Motivation?
  - Loss of Creativity?

CMMI Bottoms-Up Assessment: a Grounded Analysis from the Perspective of Practicing Engineers in Defense Engineering

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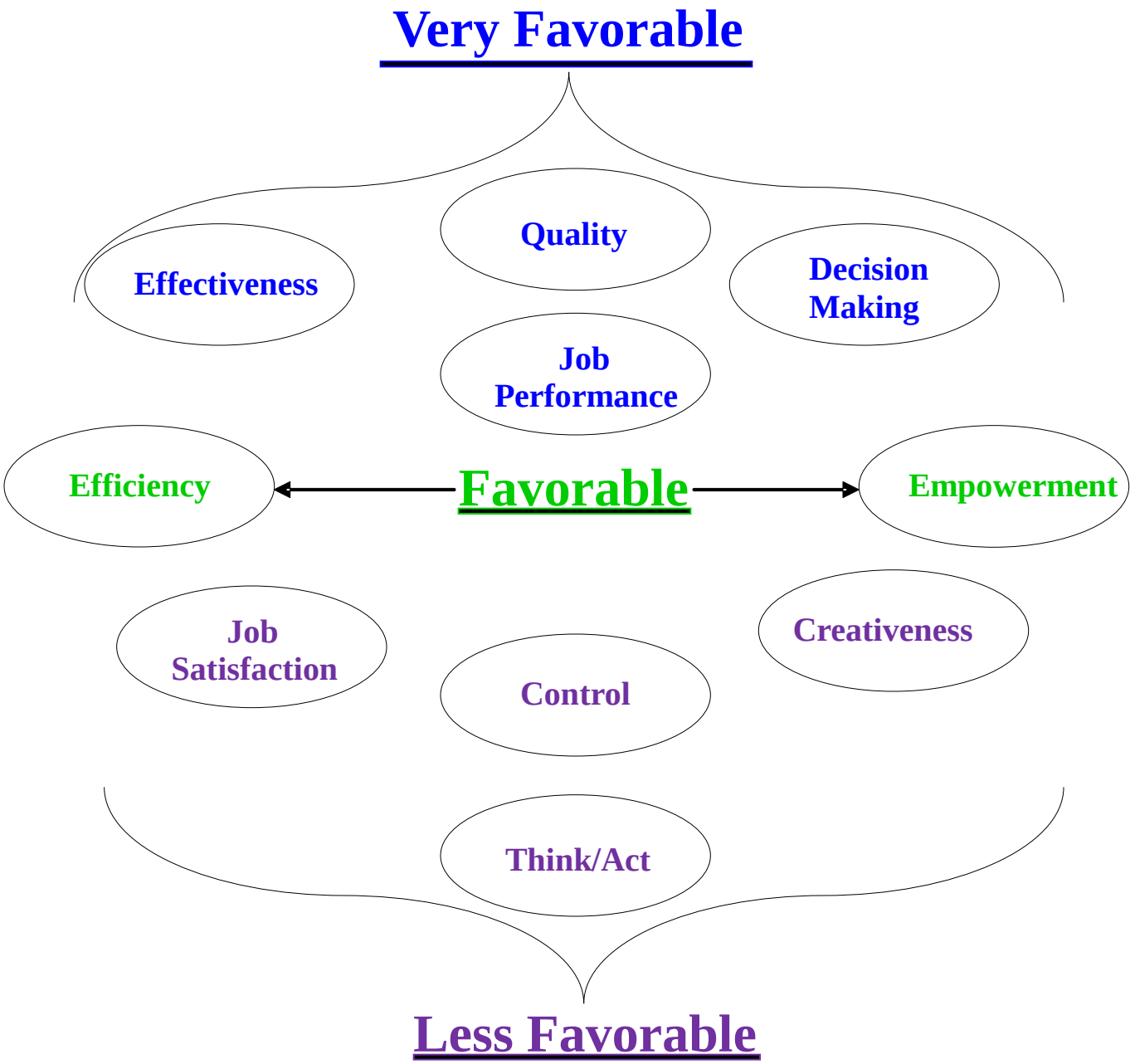
CMMI as Contemporary Iron Cage: a Grounded Analysis from the Perspective of Practicing Engineers in Defense Engineering. St. Paul, MN: University of St. Thomas doctoral dissertation.

Case Study Background

- **Purpose:** Determine how CMMI Practitioners (Engineers) viewed the effects of the CMMI on their **Job Performance** & **Job Satisfaction** at Defense Engineering (pseudonym)
- **Defense Engineering** went through 2 CMMI V1.2 Appraisals during this case study period: ML3 & ML5
- **Case Study Approach:**
  - **12 Engineers** (HW, SW, SE, QA) participated in study who had actively implemented CMMI requirements / capabilities on their Projects and participated in CMMI appraisals:
    - Typical use of CMMI Ranged from 2 to 5 years
    - Engineering Experience Ranged from 9 to 35+ years
  - **Electronic Questionnaire** comprised of 10 Open-Ended Questions, analyzed & scored responses (Positive = +5, Neutral = 0, Negative = -5), and conducted follow-up discussions with respondents:
    - Used Qualitative and Quantitative Hybrid Analysis Methods
    - Listened to the Voices of Engineers: emails, discussions, & CMMI training sessions

How CMMI Affects Practicing Engineers



Voices of Engineers

- **Q1:** How does CMMI affect an engineering practitioner's ability to accomplish engineering work tasks **effectively**?
  - ✓ **Results: Positive (P) = 10 {83.3%}, Neutral (N) = 1 {8.3%}, Detrimental (D) = 1 {8.3%}**

- **R2 [P] –** "Very positively. There is no longer a question of what is to be done, since it is clearly documented in policies, procedures, and instructions."
- **R6 [P] –** "Policies, procedures and instructions significantly improved the stakeholder commitment from interdependent teams, resulting in more effective involvement in decisions and tasks that affect them."
- **R9 [D] –** "In all honesty, I think that the pursuit of CMMI certification, has created such detailed and strict policies, procedures, and reporting requirements that it hinders an engineer's ability to accomplish work tasks effectively, creatively, and efficiently more than it has helped."

Common Themes

- **Q1 – Perform Engineering Tasks Effectively**
  - **Positive CMMI Effects**
    - CMMI specifies what engineering tasks must be done via specific practices (SPs) and generic practices (GPs).
    - Company's CMMI Compliant Policies, Procedures, & Instructions (PPIs) specify how these engineering tasks are to be accomplished.
  - **Negative CMMI Effects**
    - CMMI may cause companies to implement too many Policies, Procedures, & Instructions (PPIs), which can overwhelm engineers from working effectively by slavishly following these PPIs unless significant tailoring is encouraged & allowed.
    - Too many Process Areas (22) and Specific/Generic Goals (116) & Practices (439) that must be implemented, institutionalized, and satisfied to attain CMMI ML5.

Voices of Engineers

- **Q2:** How does the CMMI contribute to an engineer's ability to create **quality** engineering products?
  - ✓ **Results: Positive (P) = 10 {83.3%}, Neutral (N) = 2 {16.7%}, Detrimental (D) = 0 {0%}**

- **R2 [P] –** "Very positively. Of note here is the organizational use of a standard peer review process that has done (in my opinion) the most to enhance the quality of our Engineering Products. Also, standardizing on tools has greatly affected quality."
- **R3 [P] –** "Increased – more decisions are made based on data versus engineering judgment, personal agenda, or management decree. There's no question that better processes, when used conscientiously, result in better, higher quality products."
- **R5 [P] –** "Quality has increased - Specifically use of peer reviews in a quantitative manner drives up quality."
- **R6 [N] –** "Quality of the processes and products is ultimately up to the management team. If the management team does not enforce high standards, the quality is shoddy regardless of whether or not policies, procedures, and instructions are being followed."

Common Themes

- **Q2 – Create Quality Products**
  - **Positive CMMI Effects**
    - CMMI VER & VAL – Ensures building the product right and building the right product.
    - CMMI DAR – Enables better engineering decisions based upon disciplined, rigorous quantitative analysis.
    - CMMI OPD, MA, QPM & OPP – Require use of organizational & project data, sharing of measurement data across the organization, and making process/product improvements based upon quantitative data/information.
  - **Negative CMMI Effects**
    - No Negative Statements Voiced by Engineers.

Voices of Engineers

- **Q3:** How does the CMMI affect the engineer's ability to accomplish their engineering tasks **efficiently**?
  - ✓ **Results: P = 7 {58.3%}, N = 3 {25.0%}, D = 2 {16.7%}**

➢ **R1 [P] –** "I think that the main way the CPF [Common Process Framework] has increased my task execution efficiency is with the templates they provide…."

➢ **R2 [P] –** "Very positively. As personnel move from program to program their learning curve is greatly reduced since tasks are performed consistently and the tool base is relatively the same."

➢ **R9 [D] –** "We have created an environment where it has become more important and time consuming to show that you have followed the process than it is to do the work and meet the customer's needs."

➢ **R11 [D] –** "Our policies, procedures and instructions do not scale to the size of our programs. The process leans toward large programs that can afford the overhead. Small projects gain much less value from the implementation of CMMI."

Common Themes

- **Q3 – Execute Engineering Tasks Efficiently**
  - **Positive CMMI Effects**
    - CMMI OPD, DAR, MA, OPP, QPM, VAL, & VER – Ensure building the engineering product using standardized organizational templates: plans, test procedures, and reports.
    - CMMI DAR – Standardized DAR report form used.
    - CMMI OPD, MA, QPM, & OPP – Require use of organizational & project data, sharing of measurement data across the organization, and making process/product improvement decisions based upon quantitative data/information.
  - **Negative CMMI Effects**
    - CMMI has spawned an engineering process that is too burdensome and overly focused on documenting and management reporting.
    - Only beneficial to larger projects that can afford the huge reporting/recording overhead.

Voices of Engineers

- **Q4:** What **degree of control** does your CMMI compliant policies, procedures and instructions impose on your engineering work activities?
  - ✓ **Results: P = 6 {50%}, N = 2 {16.7%}, D = 4 {33.3%}**

- **R3 [P] –** "Higher control is imposed in relation to other non-CMMI organizations where I've worked. This is expected, given the CMMI focus on process repeatability/stability and continuous improvement."
- **R10 [P] –** "The processes are supposed to control all aspects of the engineering activities, and it essentially does except for the human variations that are inevitable."
- **R9 [D] –** "I would characterize the degree of control that the policies impose to be 'over the top.' We have program reviews, engineering reviews, checkpoint reviews, PAVM [Process Asset Verification Matrix] audits, quality process audits, peer review reporting, weekly team meetings, weekly schedule meetings, monthly measures, QMP [Quantitative Management Plan] measures, EVMS [Earned Value Management System] measures, and the list goes on."

Common Themes

- **Q4 – Control Effected Organization's PPIs**
  - **Positive CMMI Effects**
    - CMMI GP 2.8 – "Monitor and Control the Process"
    - Control is necessary for process repeatability, product consistency, and predictable schedule, cost, & quality results.
  - **Negative CMMI Effects**
    - Too much control can be stifling due to layers of approvals and counterproductive due to numerous & burdensome reviews, audits, and meetings that are viewed by some engineers as non-value added.

Voices of Engineers

- **Q5:** How does the CMMI affect your ability to **think** and **act** as an engineer?
  - ✓ **Results: P = 4 {33.3%}, N = 4 {33.3%}, D = 4 {33.3%}**

➢ **R7 [P]** – "CMMI PPI [Policies, Procedures, and Instructions] encourage me to act and think as an engineer. I am exposed to the larger breadth of the program with peer reviews, PACAs [Preventative and Correction Action], and OIDs [Organizational Innovation and Deployment]."

➢ **R6 [D]** – "Policies, procedures and instructions decrease my creativity and my ability to innovate because they don't challenge me to think up my own solutions. I am provided a template for every task. I am provided a flowchart of process activities that must be followed. I am treated like a cog in a big wheel, without a mind of my own."

Common Themes

- **Q5 – Ability to Think & Act as an Engineer**
  - **Positive CMMI Effects**
    - CMMI helped shape the Common Process Framework used by engineers, which provides them with a defined structure, instructions, and specific processes to follow to create quality engineering products.
  - **Negative CMMI Effects**
    - CMMI adoption reduced and stifled engineers' creativity, innovation, and performance due to its burdensome, prescriptive,& bureaucratic processes.

Voices of Engineers

- **Q6:** How has the CMMI affected your **job performance**?
  - ✓ **Results: P = 9 {75.0%}, N = 2 {16.7%}, D = 1 {8.3%}**

➢ **R5 [P]** – "They have been useful when I've needed guidance, yet haven't been too restrictive or limiting. Once again, this has been particularly helpful when performing certain duties/tasks for the first time."

➢ **R7 [P]** – "PPI [Policies, Procedures, and Instructions] aid me in consistently creating quality work products by peer pressure, larger program knowledge by participation in non-traditional disciplines for me."

➢ **R9 [D]** – "But if you ask me if I am improving my overall job performance in getting the tasks done and getting quality products out to my customer, I'd have to say that I am a worse performer than historically because of all the process adders I have to do in order to do the same tasks."

Common Themes

- **Q6 – Engineer's Job Performance**
  - **Positive CMMI Effects**
    - CMMI based PPIs contribute to:
      - Shorter Learning Curves.
      - Performing Engineering Tasks Consistently & Uniformly.
      - Sharing of Process & Product Improvements across Projects.
      - Common use of Process & Product Measures Information.
  - **Negative CMMI Effects**
    - CMMI based PPIs are perceived as detrimental due to the numerous non-value added tasks imposed.
    - Large number of PPIs that are invoked on the Project.

Voices of Engineers

- **Q7:** How has the CMMI affected your **job satisfaction**?
  - ✓ **Results: P = 6 {50.0%}, N = 3 {25.0%}, D = 3 {25.0%}**

- **R2 [P]** – "It has made my job more satisfying. I tend to take a structured approach to tasks and problems which is right in line with the CMMI."
- **R3 [P]** – "It has improved my job satisfaction significantly. …I prefer working in an environment with clear methods based on best practices and adequate data."
- **R9 [D]** – "I go home frustrated at the barriers to efficient performance and the total lack of empowerment that I have to make it happen. I have created more documents and minutes and measures in the past several years that no one looks at once they are created."

Common Themes

- **Q7 – Level of Job Satisfaction**
  - **Positive CMMI Effects**
    - Organization's CMMI based PPIs Provide:
      - Structured Approach and Clear Methods for Engineering Tasks.
      - Based upon Best Industry Engineering Practices.
      - Ensures consistent Project Execution across the Organization.
  - **Negative CMMI Effects**
    - Organization's CMMI based PPIs have:
      - Diminished Efficiency & Empowerment due to Required Non-Value added Tasks.
      - Hampered Getting High Priority Work Accomplished.
      - Imposed a Significant Overhead Burden on Projects.

Voices of Engineers

- **Q8:** How has the CMMI affected your **decision making**?
  - ✓ **Results: P = 9 {75.0%}, N = 3 {25.0%}, D = 0 {0.0%}**

➢ **R1 [P]** – "DARs [Decision Analysis and Resolution] and PACAs [Preventive and Correction Action] are effective tools that allow you to at least partially quantify technical decisions. I have been involved in both DARs and PACAs and think they are effective."

➢ **R3 [P]** – "Increased – more decisions are made based on data versus engineering judgment, personal agenda, or management decree. There's no question that better processes and better (measurement) data, when used appropriately, result in better, more informed and more valid product decisions."

➢ **R6 [P]** – "Policies, procedures and instructions helped to lay the foundations for decision analysis and resolution that is based on weighted criteria. Overall the DAR process results in the fairest outcomes."

Common Themes

- **Q8 – Decision Making Ability**
  - **Positive CMMI Effects**
    - Implemented CMMI DAR & CAR Processes:
      - Powerful tools that Facilitate Good Decision Making due to:
        - » Structured Process to follow.
        - » Fairest of Outcomes based on Quantitative Criteria.
        - » Robust Root Cause Analyses & Defect Prevention.
  - **Negative CMMI Effects**
    - No Negative Statements Voiced by Engineers.

Voices of Engineers

- **Q9:** How has the CMMI affected your **empowerment**?
  - **Results: P = 8 {66.7.0%}, N = 1 {8.3%}, D = 3 {25.0%}**

- **R1 [P]** – "The ability to tailor is very empowering, if you are willing to do it."
- **R4 [P]** – "The CMMI demands collection of process artifacts and metrics. Development of these items helps structure the thought process and provides a broader view of the product."
- **R10 [D]** – "I do not believe that empowerment is granted by the process. It seems that the process outlines how engineering decisions are made and who has to approve them. Everything has to be checked/approved by someone else, so consequently I don't feel empowered at all."

Common Themes

- **Q9 – Feelings of Empowerment**
  - **Positive CMMI Effects**
    - CMMI Based PPIs Provide:
      - Ability to Tailor Processes & Practices.
      - Use of Integrated Product Teams (IPTs).
      - Collection of Common Artifacts, Measures, and Data.
      - Team Involvement in DAR (Decision Analysis & Resolution) Project Decisions.
  - **Negative CMMI Effects**
    - CMMI Based PPIs Provide:
      - Fear of Process & Product Audit Noncompliance Findings.
      - Inhibits Empowerment due to Multiple Levels of: Checking, Verifications, and Approvals.

Voices of Engineers

- **Q10:** How has the CMMI affected your **Creativeness**?
  - ✓ **Results: P = 7 {58.4%}, N = 1 {8.3%}, D = 4 {33.3%}**

- **R1 [P]** – "A frequent criticism that I hear is that they 'limit creativity' … I do NOT think this is the case, especially with well thought tailoring."
- **R7 [P]** – "Creativity is enhance[d] by exposure to larger scope of program."
- **R6 [D] –** "Policies, procedures and instructions restrict my creativity by not allowing me to try different solutions that I feel would work better."
- **R9 [D] –** "It has stifled it to a great extent. We spend more and more time measuring, documenting, reporting and convincing than we do actually doing the real engineering work."

Common Themes

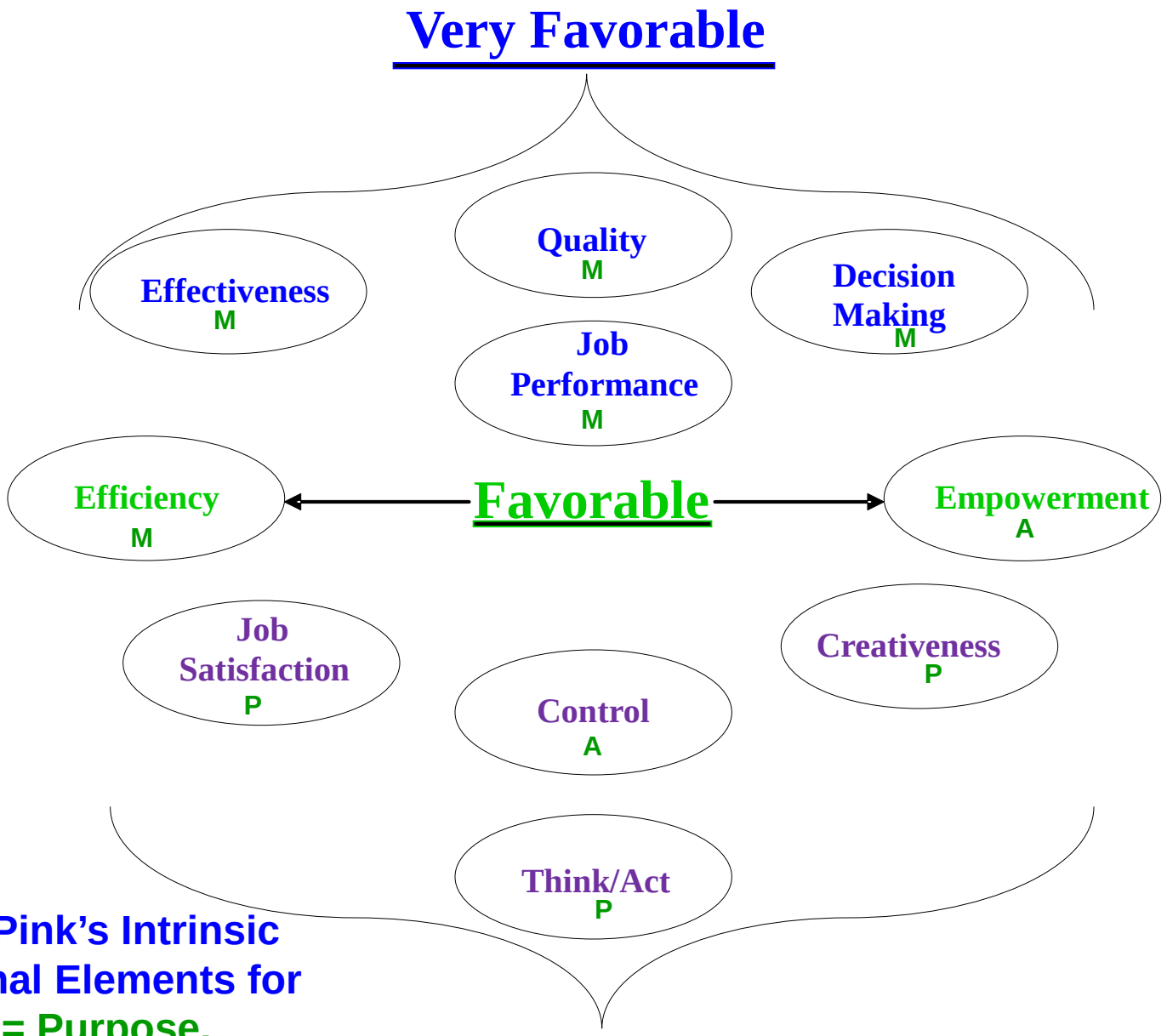
- **Q10 – Feeling of Creativeness**
  - **Positive CMMI Effects**
    - Tailoring of PPI Processes Enables Creativity.
    - Consistent use of PPI Processes allows Creativity in Engineering Solutions.
    - Common Process Framework (CPF) Flexibility Encourages Creativity.
  - **Negative CMMI Effects**
    - CPF Restricts use of Non-standard, Different, or Innovative Engineering Solutions.
    - Excessive Burden of Measuring, Documenting, & Reporting Stifles Creativity.
    - Creativity does not Spring from Process but is Intrinsic to an Engineer.

CMMI Case Study Conclusions & Recommendations

People Implications

- What Really Motivates People?
- According to Daniel H. Pink "Drive" there are 3 Fundamental Intrinsic Motivational Elements:
  - **Purpose – "Live a Life of Purpose"**
    - Have worthwhile goals to strive for and achieve!
  - **Autonomy – "Direct Our Own Lives"**
    - Become empowered to think, act, and achieve your goals!
  - **Mastery – "Extend and Expand Our Abilities"**
    - Have the determination, capacity, and ability to build: capable processes, reliable products, and valuable relationships!

How CMMI Affects Practicing Engineers



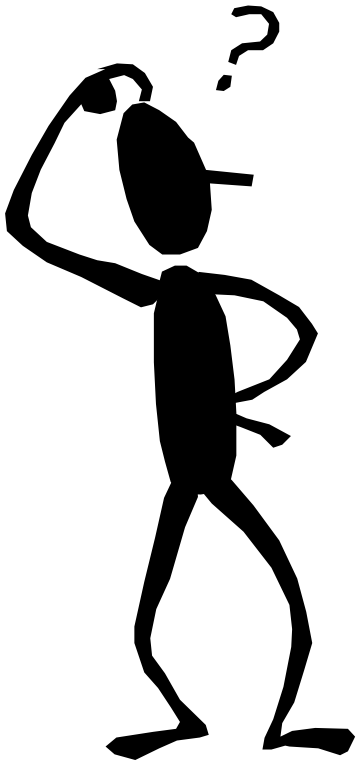
Applying Pink's Intrinsic Motivational Elements for People: P = Purpose, A = Autonomy, M = Mastery

Conclusions

- **CMMI Suboptimization:** CMMI is overly Focused on 1 Element (Process) of Engineering Product Development Framework:
  - People Execute Processes to Build Products!
  - People Make Processes Viable & Successful!
  - People are the Prime Movers & Users of Processes & Technologies!
  - People → Processes → Technology: Are the CMMI Silver Bullets that Fred Brooks denied, but only when synergistically blended within the organization's Engineering Product Development Framework!

Recommendations

- **How can we help Engineers (CMMI Practitioners) better <u>Utilize & Practice the CMMI</u> to <u>Improve</u> their <u>Job Performance</u> & <u>Job Satisfaction</u>?**
  - Watts Humphrey → TSP (Team Software Process) → CMMI Practitioners
  - Agile Processes → CMMI Practitioners
  - Six Sigma Toolkit → CMMI ML4 & ML5 Practitioners
  - People CMM → CMMI Practitioners
  - Daniel Pink ("Drive") understand what Motivates People: Purpose, Autonomy, & Mastery → CMMI Practitioners
  - Dr. B → Provide Acknowledgement, Recognition, & Appreciation → CMMI Practitioners
  - Think: People (1st) → Processes (2nd) →Technology (3rd)

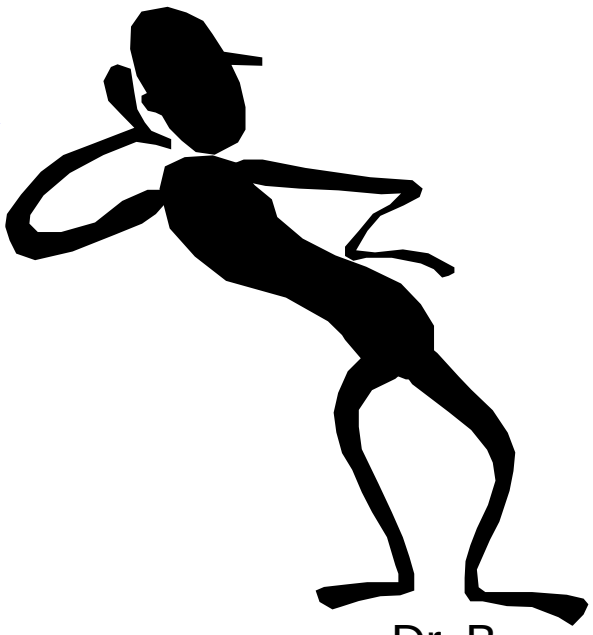


Bruce

Questions?

Comments?

Thank You!



Dr. B

Backup Slides & Supporting Information

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Case Study Approach & Questions

Selected 10 CMMI attributes & assessed how engineers perceived how these attributes affected their job performance and job satisfaction:

1. How has the use of your CMMI compliant policies, procedures and instructions affected your ability to accomplish engineering work tasks **effectively**?
2. How has the use of your CMMI compliant policies, procedures and instructions affected the **quality** of the engineering products that you create?
3. How has the use of your CMMI compliant policies, procedures and instructions affected your ability to accomplish engineering work tasks **efficiently**?
4. How would you characterize the **degree of control** that your CMMI compliant policies, procedures and instructions impose on your engineering work activities?
5. How have your CMMI compliant policies, procedures and instructions affected your ability to **think and act as an engineer**?
6. How have your CMMI compliant policies, procedures and instructions affected your **job performance**?
7. How have your CMMI compliant policies, procedures and instructions affected your **job satisfaction**?
8. How have your CMMI compliant policies, procedures and instructions affected your ability to **make valid engineering product decisions**?
9. How have your CMMI compliant policies, procedures and instructions affected your **empowerment to make good engineering decisions**?
10. How have your CMMI compliant policies, procedures and instructions affected your **creative ability** in doing your engineering work tasks?

Case Study Approach Scoring

- Engineers' attitudes or feelings about a CMMI factor were grouped into 3 response categories: Positive (P), Neutral (N), & Detrimental (D). These categories have the following meanings & values:
  - "**P**" means that this CMMI attribute has a strong perceived positive, constructive, and desirable effect on the respondent's work activities (cognitive and / or behavior). Assigned value = **+5**.
  - "**N**" means that this CMMI attribute has virtually no perceived effect (i.e. Neutral) on the respondent's work activities (cognitive and / or behavior). Assigned value = **0**.
  - "**D**" means that this CMMI attribute has a strong perceived detrimental, negative, or undesirable effect on the respondent's work activities (cognitive and / or behavior). Assigned value = **-5**.

Table 2 – Rank Ordering of CMMI Attributes Matrix

CMMI Attribute Questions & Rank / Respondents	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	Value
Q2: Quality Rank = 1	P 5	P 5	P 5	N 0	P 5	N 0	P 5	P 5	P 5	P 5	P 5	P 5)	50
Q1: Effectiveness Rank = 2	P 5	P 5	P 5	P 5	P 5	P 5	P 5	P 5	D -5	N 0	P 5	P 5	45
Q8: Decision Making Rank = 2	P 5	N 0	P 5	P 5	P 5	P 5	P 5	P 5	N 0	P 5	N 0	P 5	45
Q6: Job Performance Rank = 3	N 0	P 5	P 5	P 5	P 5	P 5	P 5	P 5	D -5	N 0	P 5	P 5	40
Q3: Efficiency Rank = 4	P 5	P 5	N 0	N 0	P 5	N 0	P 5	P 5	D -5	P 5	D -5	P 5	25
Q9: Empowerment Rank = 4	P 5	P 5	P 5	P 5	P 5	D -5	P 5	P 5	D -5	D -5	N 0	P 5	25
Q7: Job Satisfaction Rank = 5	N 0	P 5	P 5	N 0	P 5	P 5	P 5	P 5	D -5	D -5	D -5	N 0	15
Q10: Creativeness Rank = 5	P 5	P 5	N 0	P 5	P 5	D -5	P 5	P 5	D -5	D -5	D -5	P 5	15
Q4: Control Rank = 6	P 5	P 5	P 5	D -5	D -5	D -5	N 0	P 5	D -5	P 5	P 5	N 0	10
Q5: Think & Act Rank = 7	N 0	N 0	N 0	P 5	N 0	D -5	P 5	P 5	D -5	D -5	D -5	P 5	0
Algebraic Totals	35	40	35	25	35	0	45	50	-35	0	0	40	270

CMMI (V1.2) - 5 Maturity Levels

Totals:116 Goals (SG + GG) & 439 Practices (SP + GP)

Maturity Level	Focus	22 Process Areas
5 Optimizing	Continuous Process Improvement & Defect Prevention [2]	(OID) Organizational Innovation and Deployment (CAR) Causal Analysis and Resolution
4 Quantitatively Managed	Quantitative Management [2]	(OPP) Organizational Process Performance (QPM) Quantitative Project Management
3 Defined	Engineering & Organization Process Standardization – Qualitative Management [11]	(RD) Requirements Development (TS) Technical Solution (PI) Product Integration (VER) Verification (VAL) Validation (OPF) Organizational Process Focus (OPD) Organizational Process Definition + IPPD (OT) Organizational Training (IPM) Integrated Project Management + IPPD (RM) Risk Management (DAR) Decision Analysis and Resolution
2 Managed	Basic Project Management [7]	(RM) Requirements Management (PP) Project Planning (PMC) Project Monitoring and Control (SAM) Supplier Agreement Management (MA) Measurement and Analysis (PPQA) Process and Product Quality Assurance (CM) Configuration Management
1 Initial	Ad Hoc & Chaotic [~0]	Few Processes Documented or Followed – Land of the "Cowboys & Cowgirls" – "Don't Need No Stinking Processes!"