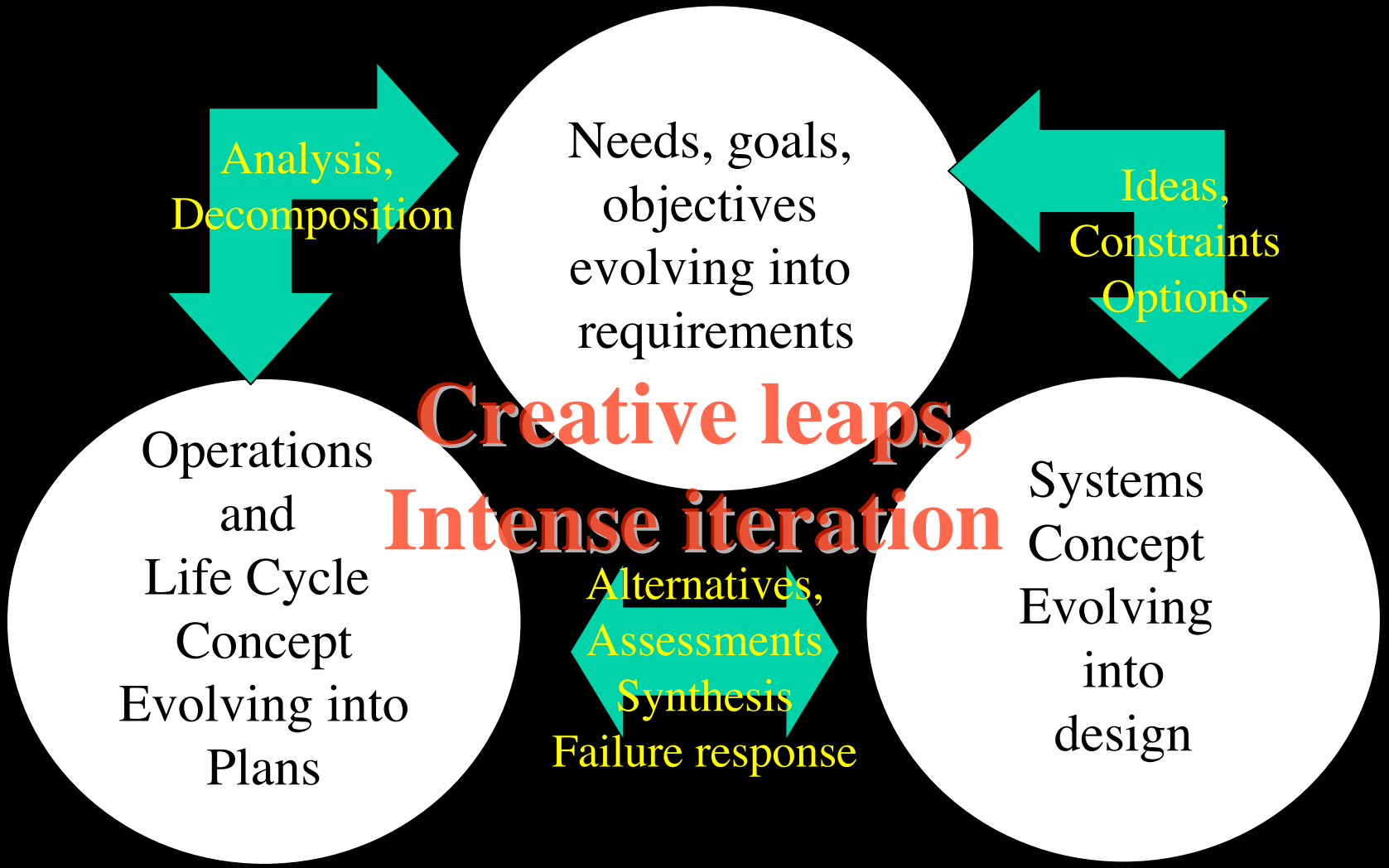
Creation, Synthesis, Leadership, Credibility, Intuition
What in the world do these have to do with Systems Engineering?

M.G. Ryschkewitsch
NASA Chief Engineer

What is Systems Engineering?

Systems engineering is the art and science of developing an operable system that can meet requirements within imposed constraints. It is holistic and integrative and incorporates and balances the contributions of the "standard" engineering disciplines plus cross-cutting ones to produce a coherent whole that no single discipline dominates. Systems engineering is about tradeoffs and compromises, about generalists rather than specialists.

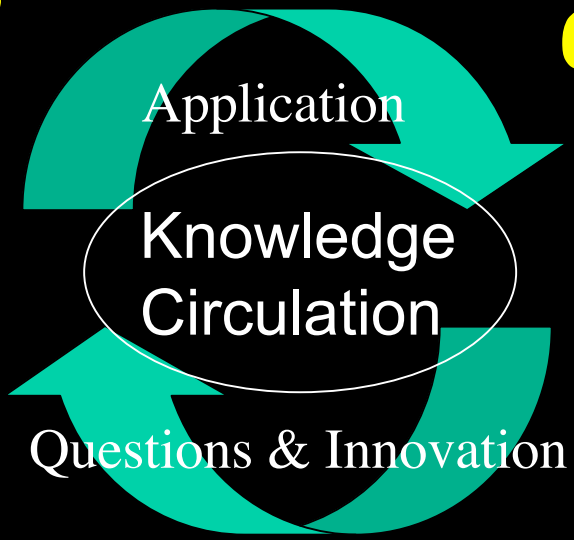
Creation of new systems requires engineering science, art and lots of perspiration



There is no cookbook which can guarantee success but there are necessary ingredients

Completeness

Information, tools, techniques



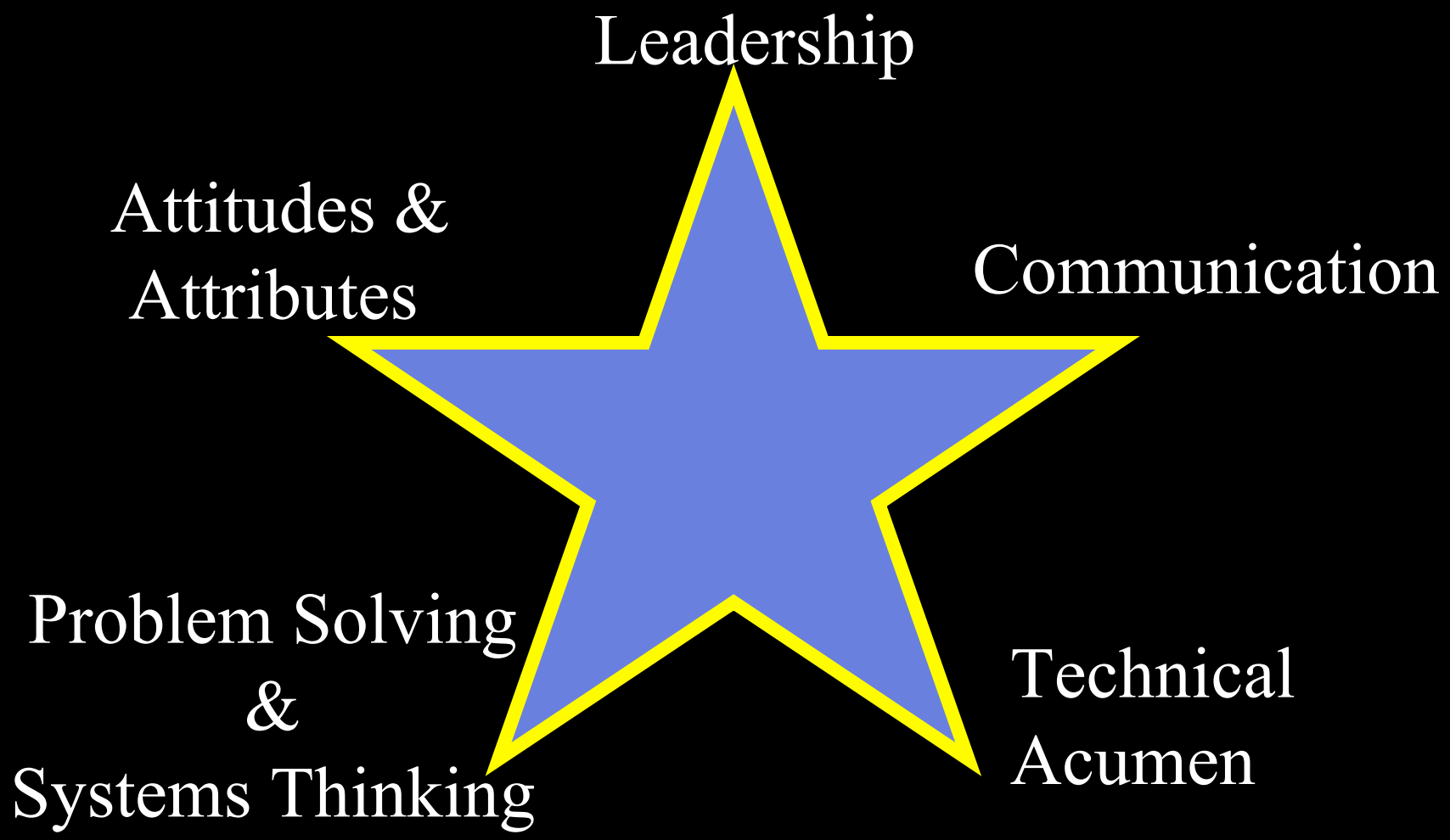
Consistency

Policy, Process

Creativity

Competencies
Human Behaviors
Culture of rigorous inquiry

A NASA-centric Study - What makes a great systems engineer



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Technical Acumen

- Learns from Successes and Failures
  - Shares with other lessons learned. Lessons come from a strong base of engineering experiences across the full life-cycle.
  - Documents and studies the successes and failures of both the current and previously developed systems. Uses this information to make decisions that reduce risk and maximize the probability of success.
  - Willing to learn from past failures as well as successes. Understands both are important.

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Technical Acumen

- Possesses Technical Competence and Has Comprehensive Previous Experience
  - Shares project experience and acts as a reliable resource to the team and serves as the ‘go to’ person
  - Demonstrates the depth of technical knowledge and expertise necessary to perform, manage, and coordinate work-related activities.
  - Possesses a strong, fundamental understanding of engineering principles along with a cross disciplinary background.
  - Demonstrates ability to focus on details while keeping the big picture in mind. Able to shift focus between the two with ease

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Problem Solving
&
Systems Thinking

- Identifies the Real Problem
- Assimilates, Analyzes, and Synthesizes Data
- Thinks Systemically
- Has the Ability to Find Connections and Patterns Across the System
- Sets Priorities
- Keeps the Focus on Mission Requirements
- Possesses Creativity and Problem Solving Abilities
- Validates Facts, Information and Assumptions
- Remains Open Minded and Objective
- Draws on Past Experiences
- Manages Risk

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Attitudes & Attributes

- Remains Inquisitive and Curious
- Seeks Information and Uses the Art of Questioning
- Advances Ideas
- Gains Respect Credibility, and Trust
- Possesses Self-Confidence
- Has a Comprehensive View
- Possesses a Positive Attitude and Dedication to Mission Success
- Is Aware of Personal Limitations
- Adapts to Change and Uncertainty
- Uses Intuition/ Sensing

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Communication

- •Listens Effectively and Translates Information
- •Communicates Effectively Through Personal Interaction
- •Facilitates an Environment of Open and Honest Communication
- •Uses Visuals to Communicate Complex Interactions
- •Communicates Through Story Telling and Analogies
- •Is Comfortable with Making Decisions

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Leadership

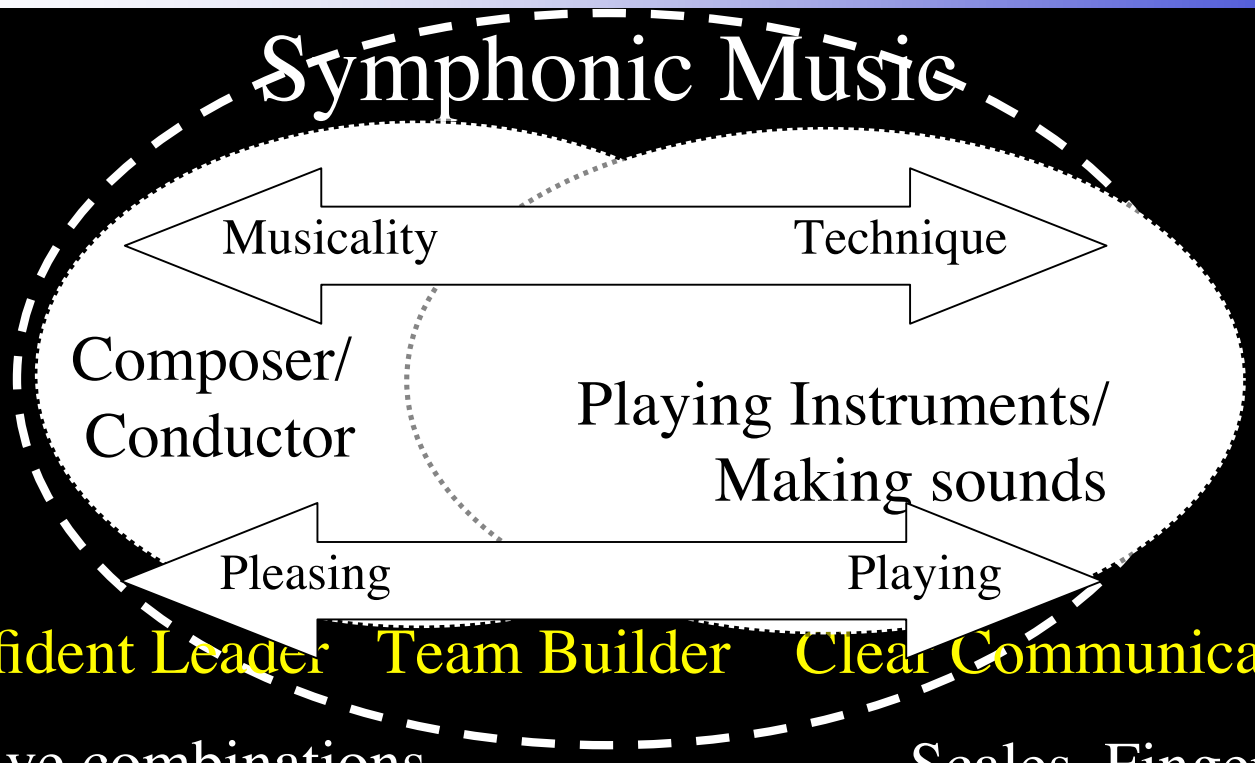
- Creates Vision and Direction
- Ensures System Integrity
- Sees Situations Objectively
- Appreciates/ Recognizes Others
- Builds Team Cohesion
- Understands the Human Dynamics of a Team
- Possesses Influencing Skills
- Coaches and Mentors
- Delegates
- Ensures Resources are Available

Leadership

"A team is made up of many individuals. The more individualistic, the better. When putting a team together, the director should not try to find people whom he can outsmart, but people who are smarter than he is.."

Then comes a test of leadership. All the people around the table are experts in their own field. Each one should be a strong individual, with strong feelings, capable of thinking problems through on his own -- or he should not be there. When a conflict arises, the director must be able to find a compromise solution that is best for the satisfactory accomplishment of the mission, and get willing agreement from the dissenters.

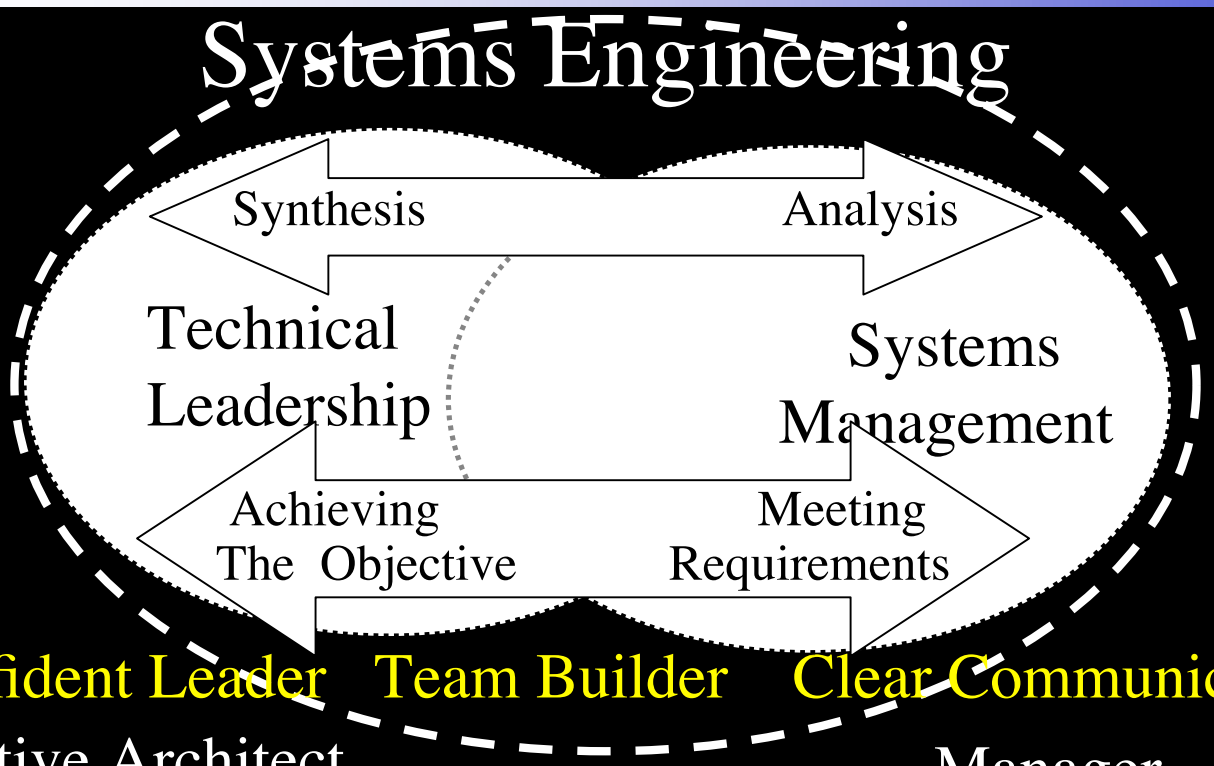
Playing Instruments and Making Music



Creative combinations
Musical message
Artistic interaction

Scales, Fingering
Musical forms
Timing, cadence
Arrangements

How is the Systems Engineering we need different than what we teach?



Confident Leader — Team Builder — Clear Communicator

Creative Architect
Problem finder
Constructive Paranoid
Big Picture Thinker

Manager
Organizer
Process Controller
Detailed Verifier

The Price of not asking “why”

Suggested reading

----Mike Griffin, speech on the two cultures of engineering at Purdue University, March 28, 2007
http://www.nasa.gov/news/speeches/admin/mg_speech_collection_archive_2.html

----Ferguson, E.S. (1992) Engineering in the Mind's Eye. Cambridge, MA: MIT Press.

----Henry Petroski
- "Success through Failure: The Paradox of Design", Princeton University Press, 2006
- "To Engineer is Human", Vintage Books, 1992

----J.E. Gordon, "*Structures: or, Why Things Don't Fall Down*", 1978