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Edinburgh, UK

July 18 - 21, 2016

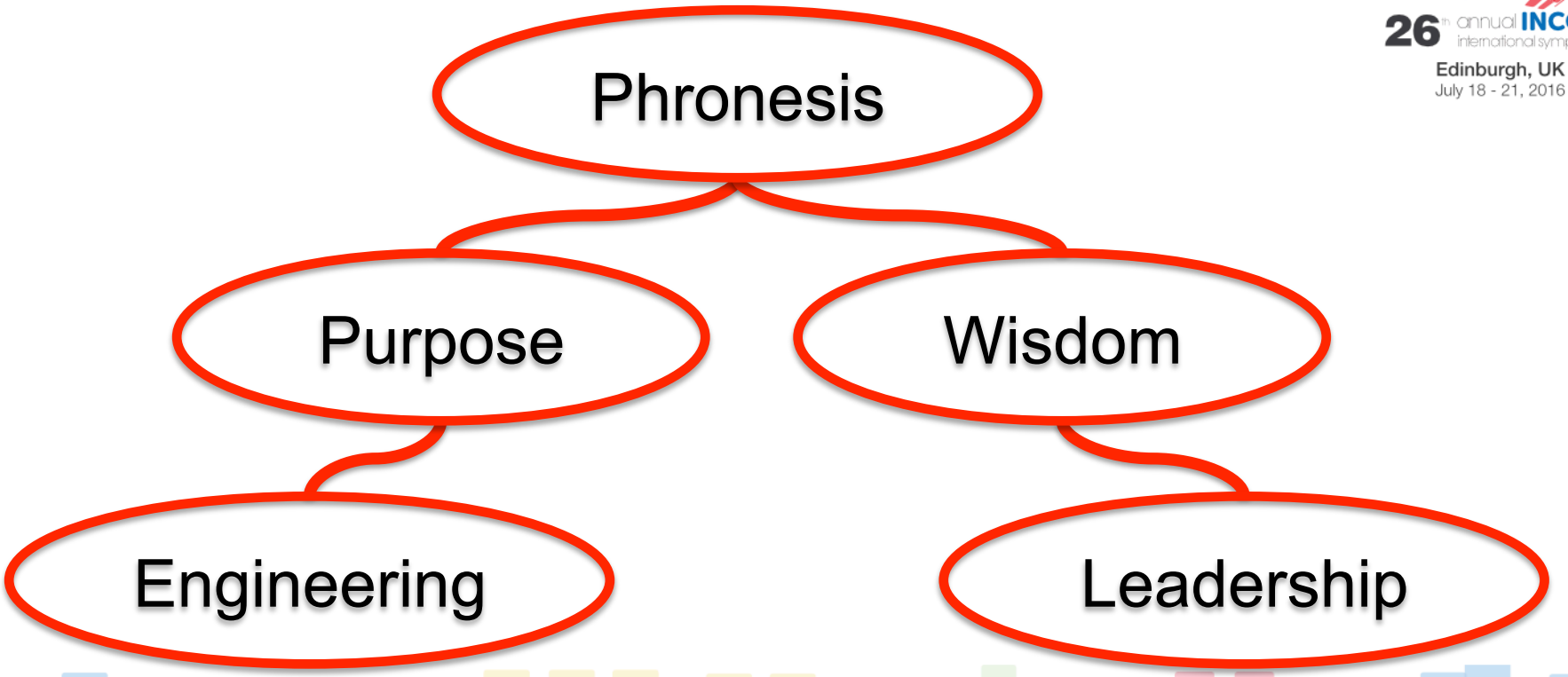
Systems Engineer: the ultimate phronetic leader?

Author: Vincenzo Arrichiello

presented by: Lucio Tirone

AISE - INCOSE Chapter Italia

The *"fil rouge"*

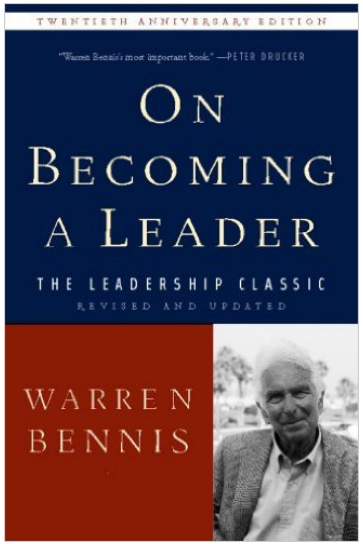


What is Leadership?

The ability to do the right thing

"the leader does the right thing"
Warren Bennis, "On Becoming a Leader"

The ability to take *wise* decisions under conditions of uncertainty, incomplete information and high complexity.



WICS model of Leadership

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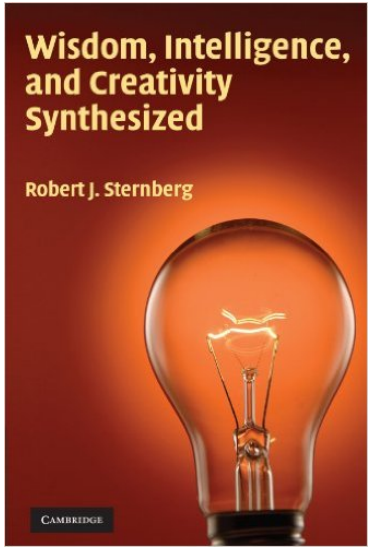
Wisdom, Intelligence, and Creativity, Synthesized

Robert J. Sternberg

Intelligence:
"one's ability to attain one's goals in life, given one's socio-cultural context, by adapting to, shaping, and selecting environments, through a balance of analytical, creative, and practical skills."



This ability is based on fundamental **executive processes**:
"recognizing the existence of a problem, defining and redefining the problem, allocating resources to the solution of the problem, representing the problem mentally, formulating a strategy for solving the problem, monitoring the solution of the problem while problem solving is ongoing, and evaluating the solution to the problem after it has been solved"

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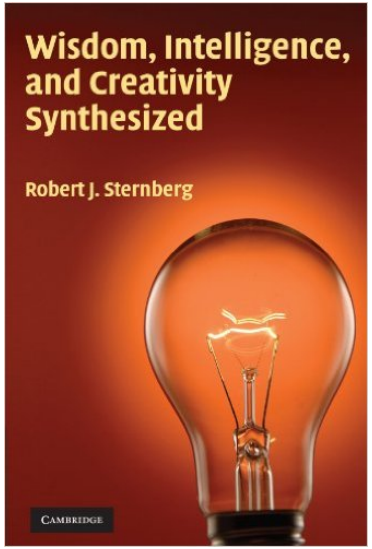
Intelligence:

- Analytical intelligence
- Creative intelligence
- Practical intelligence



Creativity

Builds on Intelligence but it requires also:

- knowledge
- a desire to think in novel ways
- personality attributes
- intrinsic, task-focused motivation
- an environment that supports creativity

WICS model of Leadership

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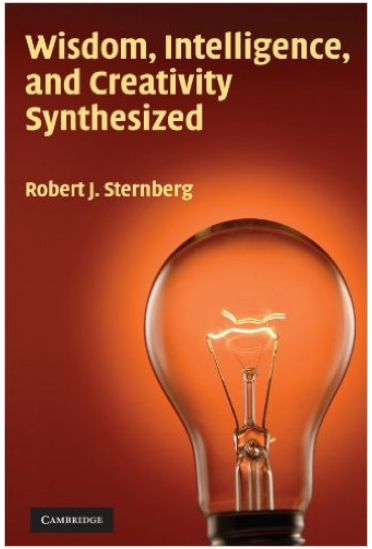
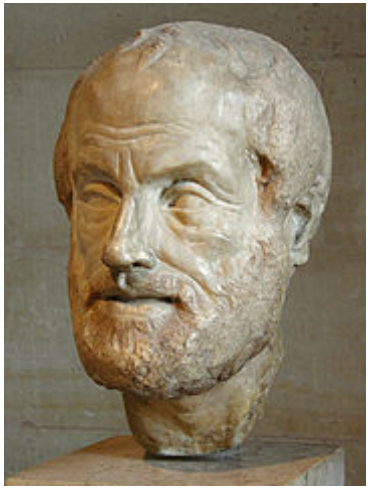


Wisdom is *"the most important quality a leader can have"*, as it makes one able "to use one's successful intelligence, creativity, and knowledge toward a common good by balancing one's own (intrapersonal) interests, other people's (interpersonal) interests, and larger (extrapersonal) interests, over the short and long terms."

Phronesis: Aristotle

"ωστ' αναγκη την φρονησιν εξιν ειναι μετα λογου αληθη περι τα ανθρωπινα αγαθα πρακτικην"

"It therefore follows, out of necessity, that practical wisdom (phronesis) is a truth-attaining rational quality, concerned with action in relation to the things that are good for human beings.“

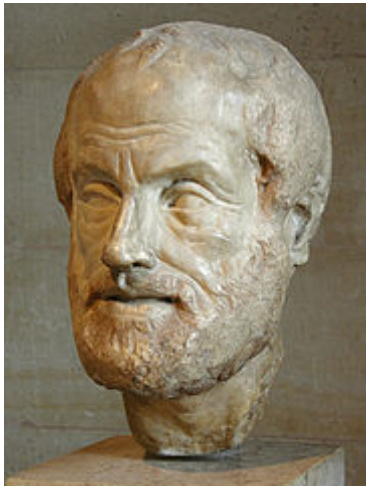


Portrait of Aristoteles
Credit : Eric Gaba, Creative Commons

Phronesis: Aristotle

Phronesis (practical wisdom) is needed to complement techne (art), episteme (scientific knowledge), sophia (philosophic wisdom), and nous (intuitive reason), five "states by virtue of which the soul possesses truth".

Phronesis: the rational quality that enables deliberation about action aimed at the common human good, and about the means to perform it



Portrait of Aristoteles
Credit : Eric Gaba, Creative Commons

Phronesis: Thomas Aquinas

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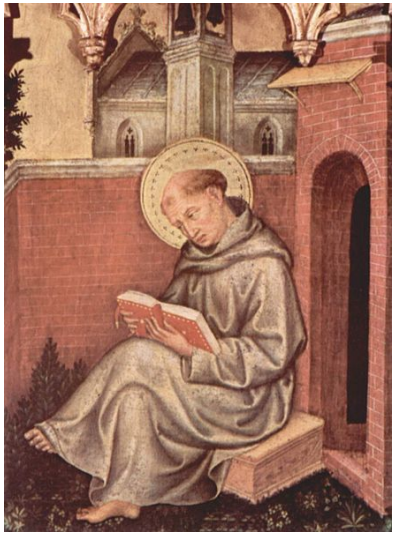
“Prudentia” is the first of the “cardinal virtues”
Eight "quasi-integral parts" of prudence

- Memoria (Memory)
- Intellectus vel intelligentia (Understanding)
- Docilitas (Docility)
- Solertia(Shrewdness)
- Ratio (Reason)
- Providentia (Foresight)
- Circumspectio (Circumspection)
- Cautio (Caution)

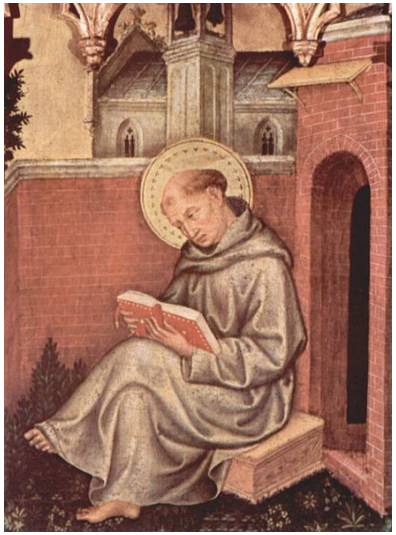


S. Tommaso d’Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

Phronesis: Thomas Aquinas

Memoria (Memory)
"we need experience to discover what is true in the majority of cases [and] experience is the result of many memories"

Intellectus vel intelligentia (Understanding)
"[Prudence requires a] twofold understanding: the one is cognizant of universals [principles] and the other is cognizant of ... contingent practical matter"

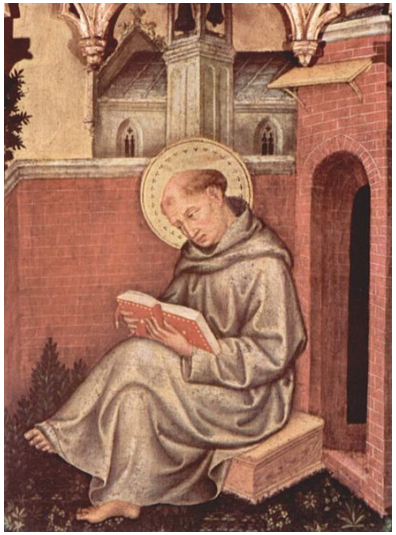


S. Tommaso d'Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

Phronesis: Thomas Aquinas

Docilitas (Docility)
"in matters of prudence man stands in very great need of being taught by others, especially by old folk who have acquired a sane understanding of the ends in practical matters"

Solertia (Shrewdness)
"disposition to acquire a right estimate by oneself [and of] grasping quickly what should be done."

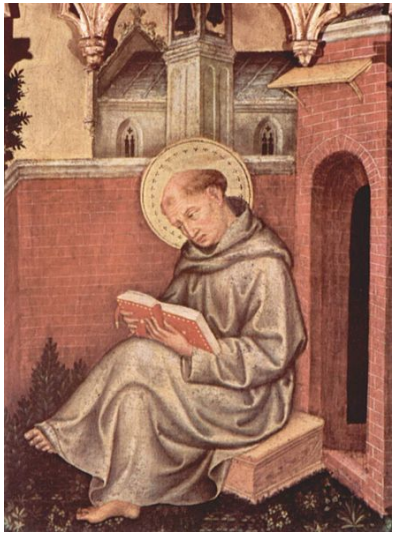


S. Tommaso d'Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

Phronesis: Thomas Aquinas

Ratio (Reason)
"not the power of reason, but its good use"
Reason is needed to "rightly apply universals to particulars, which latter are various and uncertain"

Providentia (Foresight)
"foresight is the principal of all the parts of prudence." It "implies the notion of something distant, to which that which occurs in the present has to be directed"

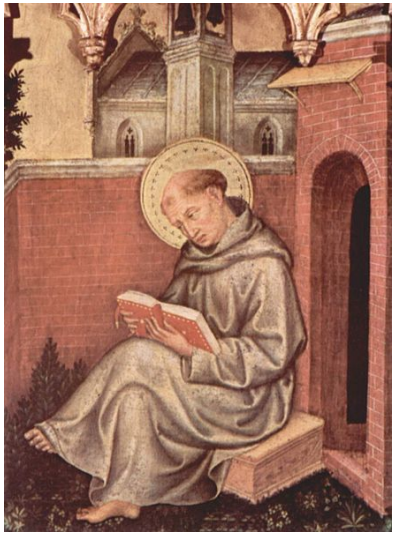


S. Tommaso d'Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

Phronesis: Thomas Aquinas

Circumspectio (Circumspection)
to look around (circum-specere) to the combinations of circumstances which may make "evil or unsuitable to the end" a thing "good in itself and suitable to the end"

Cautio (Caution)
caution must be exerted to "avoid evil" and to try to prevent obstacles to, and the undesired consequences of, one's own actions



S. Tommaso d'Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

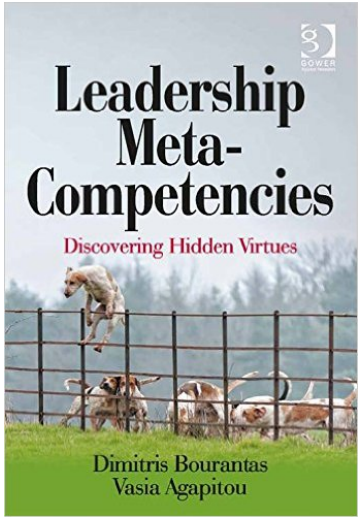
Phronesis: Dimitris Bourantas

"Phronesis: a strategic leadership virtue"

"the need for phronesis is growing today, as a consequence of the increasing complexity and scope of the problems faced by organizations"

Leader's traits and skills related to phronesis:

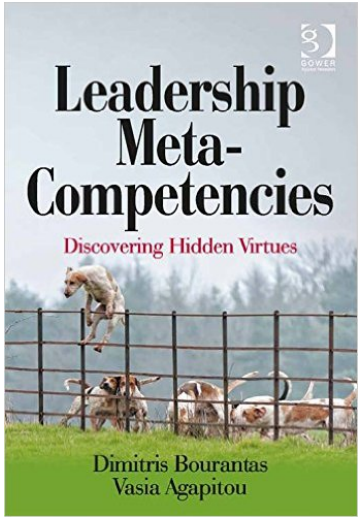
- **Cognitive Abilities**
  - Mindfulness
  - Systems Thinking
  - Tacit Knowledge
- **Meta-cognitive abilities**
  - Intra-personal Intelligence
  - Inter-personal intelligence
  - Existential Intelligence



Phronesis: Dimitris Bourantas

Phronesis effects on leaders' effectiveness

- **Managing paradoxes** (to "implement diverse courses of action with flexibility, taking into consideration others' needs)
- **Self-concept** (allows one to take on challenges that match one's skill level)
- **Humility** (makes leaders "eager to learn from their experiences and from others)
- **Authenticity** (to remain true to own core values, and to be likely to sacrifice self interests for the collective good)



Phronesis: others

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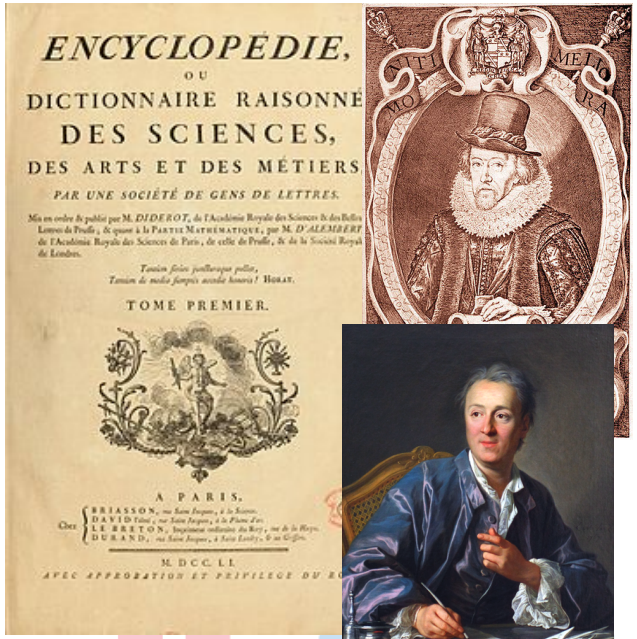
Bent Flyvbjerg:
"***Phronesis*** is most important, from an Aristotelian point of view, because it is that intellectual virtue that ***may ensure the ethical employment of science (episteme) and technology (techne)***"
Domènec Melé:
"practical wisdom ***introduces ethics in decision making*** by ***considering both the end*** … ***pursued*** **and the means** to achieve such an end ***from the perspective of the human good***"

"Modern" Engineering

Three elements of the **Enlightenment** likely concurred in creating a cultural environment that fostered the birth of modern engineering:

- the belief in the possibility of **human progress through reason and knowledge**
- **the praise of "mechanical arts"** as *"arts utiles"* (useful arts)
- the belief that **"the expansion of useful knowledge would solve technological problems"** (Diderot)

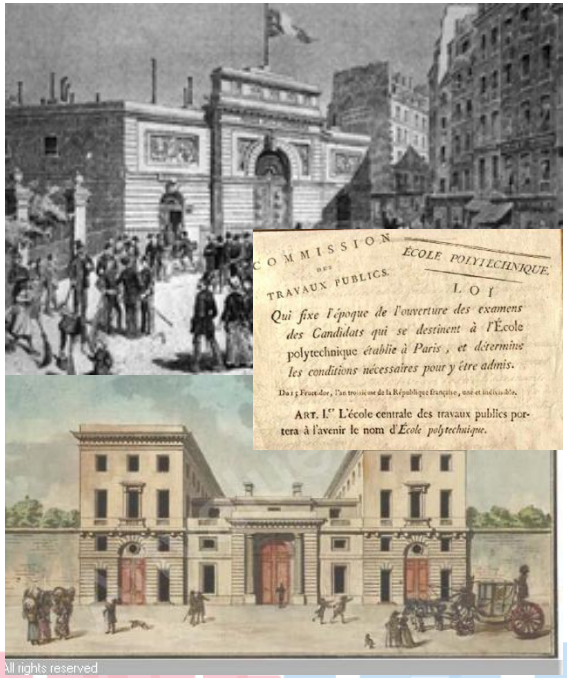


"Modern" Engineering

The beginnings of civil engineering:

- 1747 École Nationale des Ponts et Chaussées
- 1794 École centrale des travaux publics (later: École polytechnique)

To form intelligent and indispensable servants of the state working to the construction of a civilized society



Engineering purpose

"to be useful to humankind"

In very wide sense engineering can be defined as the set of all human activities directed to the use of the forces made available by nature, to the rational use of natural and artificial materials, to the production of novel and suitably modified materials, in order **to obtain better conditions of individual and social life**.

Gino Bozza

Engineering purpose

"to be useful to humankind"

"the application of science and mathematics by which the properties of matter and the sources of energy in nature are **made useful to people**"
(Merriam-Webster Dictionary)

National Academy of Engineering
1970 Symposium:
"Engineering for the Benefit of Mankind."

Systems Engineering Ethics

Responsibility to Society

"Because of the criticality and scope of many systems, **systems engineers**, operating in teams within projects and on behalf of the public in delivery of products, **have special responsibility**. Poorly designed systems or services can have calamitous effects on society."

Engineering Leadership

The call for Engineering Leadership

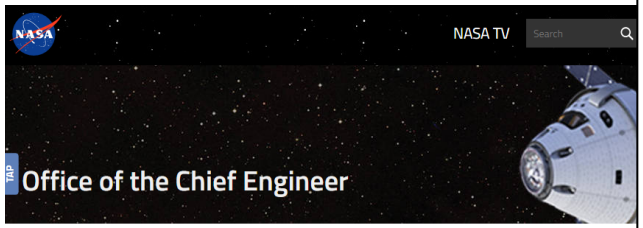
"Until engineering is prepared to ***assume greater leadership***, it will remain a most honorable and skillful profession, but it will renounce ***its legitimate role as a splendid manifestation of humankind's will to control its destiny***."

George Bugliarello

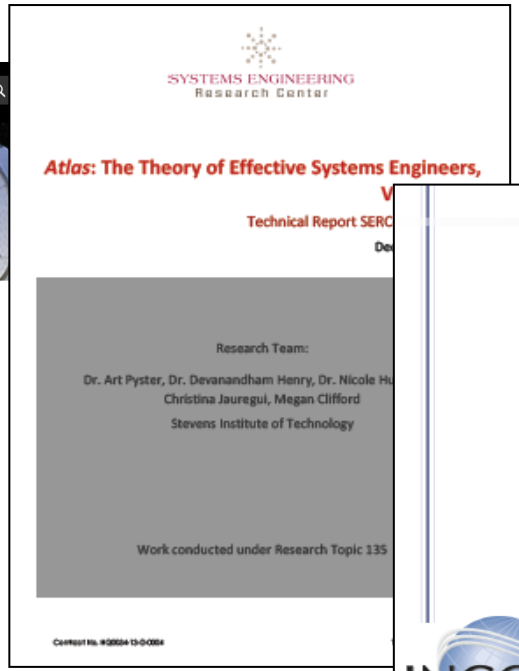
Engineering Leadership

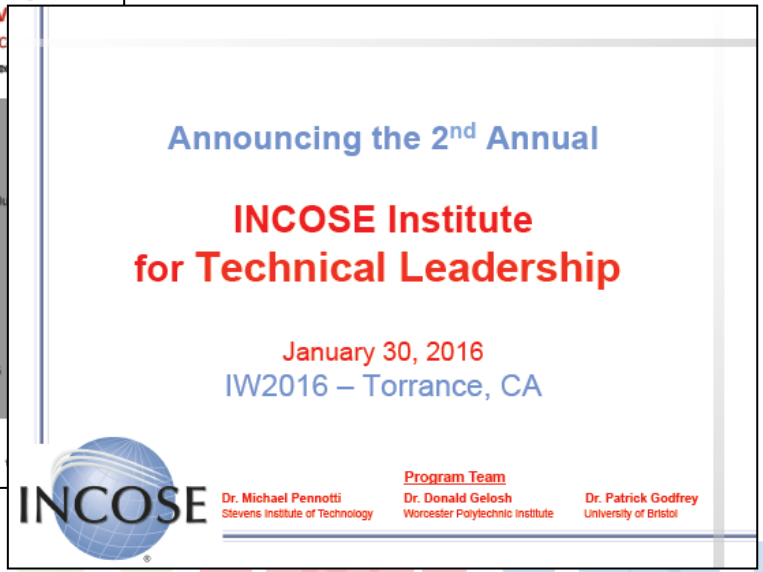
National Academy of Engineering, 2004, *The Engineer of 2020: Visions of Engineering in the New Century*
"However, with the **growing interdependence** between technology and the economic and social foundations of modern society, there will be an increasing number of opportunities for engineers **to exercise their potential as leaders**. ... In preparation for this opportunity, engineers must understand the **principles of leadership** and be able to practice them in growing proportions as their careers advance."

Systems Engineering and Leadership



NASA Systems Engineering Leadership Development Program (SELDP)





Engineering Leadership

To develop **"next-generation technical leaders equipped with the *capabilities and character* they need to address complex, real-world engineering scenarios."**

Engineering Leadership and Phronesis

Large overlapping between:

- Engineering Leadership Capabilities and the elements of Phronesis
- Engineering Leadership Capabilities and the elements of Systems Engineering Competency Models
- Effective systems engineers personal behavior characteristics and the elements of Phronesis

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Table II Comparison between Engineering Leadership Capabilities and Systems Engineering Competency Models

Capabilities of Effective Engineering Leaders (MIT ELP 2011)		Systems Engineering Competency Models (INCOSE 2010) (MITRE 2007) (NASA 2009)
	Initiative [Ability and willingness to assess risk and to take initiative]	Result Orientation (MITRE),
	Decision Making in the Face of	Decision making (INCOSE), Is Comfortable with Making Decisions (NASA)
	... Will to	High Quality Standards (MITRE), Possesses a Positive Attitude and Dedication to Mission Success (NASA)
	...nd	Adaptability (MITRE), Facilitating, Managing, and Championing Change (MITRE), Adapts to Change and Uncertainty (NASA)
	... Courage	Integrity (MITRE)
	...]	Integrity (MITRE), Building Trust (MITRE), Gains Respect Credibility, and Trust (NASA)
		Integrity (MITRE)
		Creates Vision and Direction (NASA)
		Possesses Self-Confidence (NASA)
		Knowing when to ask (INCOSE), Remains Inquisitive and Curious (NASA), Seeks Information and Uses the Art of Questioning (NASA)
		Negotiating (INCOSE)
	...]	Persuasiveness and Influence (MITRE), Possesses Influencing Skills (NASA)
	...ping	Team Working (INCOSE)

Table I Comparison between Engineering Leadership Capabilities and the elements of Phronesis

Capabilities of Effective Engineering Leaders (MIT ELP 2011)		Phronesis/Prudence elements (Aquinas 1947), (Bourantas 2008)
The Attitudes of Leadership: Core Personal Values and Character	Initiative [Ability and willingness to assess risk and to take initiative]	Shrewdness
	Decision Making in the Face of Uncertainty	Managing paradoxes
	Responsibility, Urgency and Will to Deliver	Shrewdness
	Resourcefulness, Flexibility and Change	Managing paradoxes
	Ethical Action, Integrity and Courage	Authenticity, Reason
	Trust and Loyalty [to the team]	Inter-personal Intelligence
	Equity and Diversity [in organizations]	
	Vision and Intention in Life	Existential Intelligence
	Self-Awareness and Self-Improvement	Intra-personal Intelligence, Self-concept
The Skills of Leadership: Relating	Inquiring and Dialoging	Humility, Docility
	Negotiation, Compromise and Conflict Resolution	Inter-personal Intelligence
	Advocacy [advocate a position]	
	Diverse Connections and Grouping [with those with different skills, cultures, and experiences]	Inter-personal Intelligence
	Interpersonal Skills	Inter-personal Intelligence
	Structured Communications	Inter-personal Intelligence
The Skills of Leadership: Making Sense of Context	Awareness of the Societal and Natural Context	Circumspection
	Awareness of the Needs of the Customer or Beneficiary	Circumspection

Table III Comparison between effective systems engineers personal behavior characteristics and the elements of Phronesis

Personal behavioral characteristics of effective systems engineers (NASA - Stevens Institute of Technology) (Ryschkewitsch, Schaible and Larson 2009)	Phronesis/Prudence elements (Aquinas 1947), (Bourantas 2008)
Intellectual curiosity - ability and desire to learn new things	Memory
Ability to see the big picture - yet get into the details	Systems Thinking, Understanding or Intelligence
Ability to make system-wide connections	Systems Thinking, Circumspection
Exceptional two-way communicator	Docility, Humility
Strong team member and leader	Inter-personal intelligence, Authenticity
Comfortable with change.	Managing paradoxes
Comfortable with uncertainty and unknowns	Managing paradoxes
Proper Paranoia - expect the best - but plan for the worst	Foresight, Caution
Diverse technical skills - ability to apply sound technical judgment	Reason
Self confidence and decisiveness - short of arrogance	Self-concept, Shrewdness
Appreciate the value of process - rigor and knowing when to stop	

Engineering Leadership and Phronesis

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	Equity and Diversity [in organizations.]	Integrity (MITRE)
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	Self-Awareness and Self-Improvement	Possesses Self-Confidence (NASA)

Engineering Leadership and Phronesis

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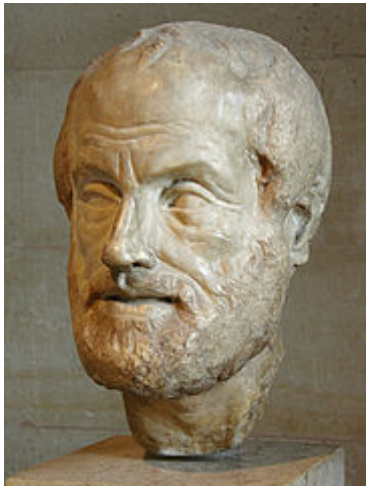
"[those who deliberate with phronesis] assume the end and consider how and by what means it is to be attained; and if it seems to be produced by several means they consider by which it is most easily and best produced"

Analysis of Alternatives?

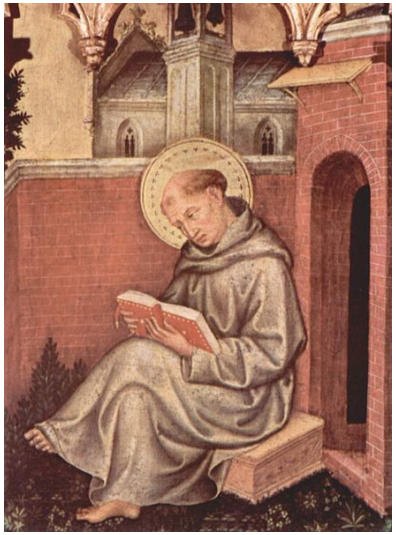


Portrait of Aristoteles
Credit : Eric Gaba, Creative Commons

Engineering Leadership and Phronesis

"Of the evils which man has to avoid, ... there are [some] that occur rarely and by chance, and these, since they are infinite in number, cannot be grasped by reason, nor is man able to take precautions against them, although by exercising prudence he is able to prepare against all the surprises of chance, so as to suffer less harm thereby.“

Proper Paranoia?



S. Tommaso d’Aquino, Polittico di Valle Romita, Gentile da Fabriano, 1400 ca., Pinacoteca di Brera, Milano (Wikimedia Commons)

Final Reflections

The purpose of the present work is not to state a finding, but just to provide some material for, and to stimulate, a reflection on the role of engineers in society.

The challenge of addressing societal problems in a global perspective in order to provide sustainable solutions, poses a heightened demand on engineers for the ability to **combine technical prowess with wisdom and ethics**, to attain **Engineering Leadership**, and ultimately to be **true phronetic leaders.**

Final Reflections

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Systems Engineering, thanks to many of the aspects of its Systems Approach, and to the special consideration it pays to the behavioral characteristics of its practitioners, appears to be in a vantage position to respond to the demand of phronetic leadership.

Thanks for your attention

Questions?