2006 National Faculty Leadership Conference

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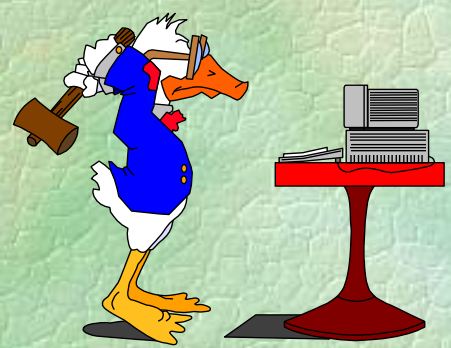
Taking our Faith to the Marketplace



Integrating Faith and Teaching

- Engineering
- Information Technology
- Nursing
- Agriculture

Introducing Christian Principles in the Engineering Workplace

Outline of the Talk

- **Faith and Human Limitation**
- **Design and What Engineers Do**
- **Theory**
- **Practice**
- **Teaching Case**

Albert Einstein "Half way to the solving of problems which we face in life is fully understanding the problems.“

David Rine

Sciences and Jesus' Gospel

- **But we are not able to fully understand.**
  - ***Engineering*** **is applied sciences.**
    - ***Design*** **is the focus of engineering.**
    - ***Technology*** **is an engineering outcome.**

(Thesis) There are Consistencies and Positive Interactions Between Bible-based Christian Faith and Design Engineering Practice.

Theory

- Bounded Rationality
- Designing Design
- Good Design

Designing Design

Herbert A. Simon--Nobel Laureate
Delivered to the First International Congress on Planning and Design Theory, Boston, 1987.
Published in Collen--pg. 246-257

The design process is shaped in fundamental ways by the fact that **human rationality is bounded**, and shaped especially by the very narrow focus of human attention. Computers enable us to handle a little more information than we could before, and compute a few more of the implications of our knowledge. But they do not change the basic fact of **bounded rationality**. With or without computers, we can take into account at one time only a tiny bit of the real world's complexity. *It follows that **design** is a process of search, and of the discovery of new information about **alternatives** that are available and about the **consequences** that will follow if those alternatives are chosen. But **design** is also a process for discovering the goals to be achieved and the constraints to be satisfied. **Goals and constraints** are no more fixed elements in design than is anything else.* Design is always tentative. At every point of time, the design is subject to revision. And to the end of the life of the designed object, that object and its uses are subject to revision. **A major goal** at each step of the design process is to realize goals while keeping options for the future open. Design needs to be approached with a modesty about our ability to anticipate the future, much less to control it wisely. **Good design** decides on goals and chooses alternatives without preempting the choices of goals that our successors may wish to make.

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- Faith and Human Limitation
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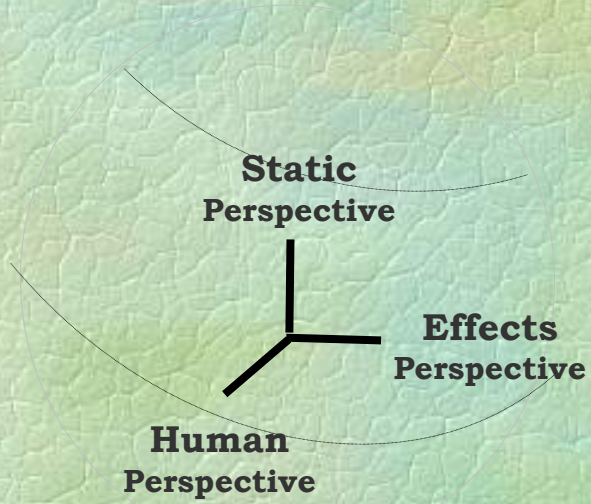
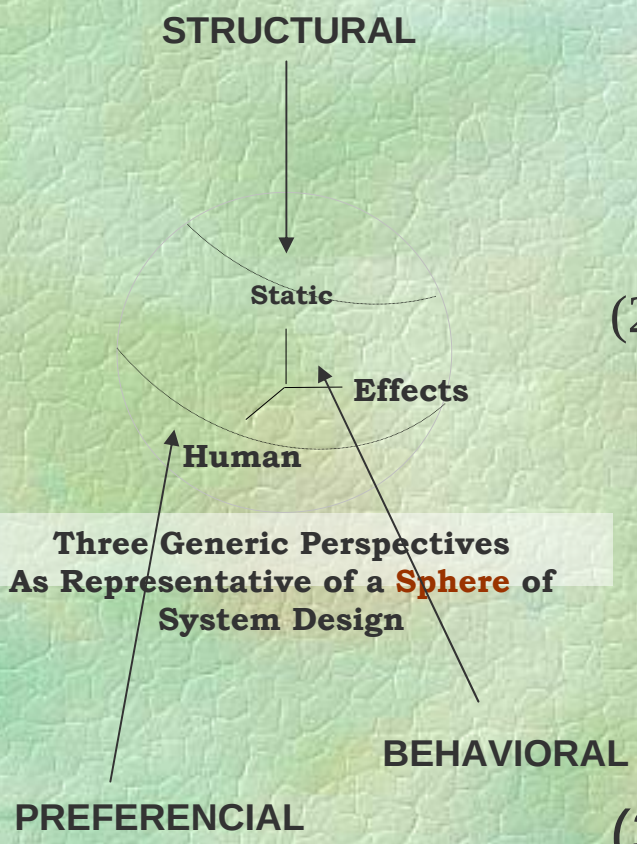
Problem Solving: Understanding or Improvement

- Closed Approach
  - A Priori Rationalism
  - Deductive proofs based upon belief systems
  - Correctness
- Open Approach
  - Interactive Empiricism
  - Testing hypotheses based upon learning systems
  - Validation
- Random Approach
- Design Approach

Designing Design: The Orthogonal Design Perspectives



Three Generic Perspectives As Representative of a Sphere of Engineering Design



Three Generic Perspectives As Representative of a Sphere of System Design

(1) Human perspective: judgments, purposes, priorities, values, preferences, reasons and other "Bases for. " This "representative" perspective is shown down to the left--as the foundation perspective. **(H)**

(2) **Static** perspective: products, resources, structure, funding, personnel, facilities, schedule, methods, tools, languages, models, and other "Means to." This "representative" perspective is shown vertically up and down--as the perspective of "static" resources, methods, facilities, etc. **(S)**

(3) **Effects** perspective: functions, actions, results, assessments and other Effects of this "representative" perspective is shown horizontally left and right as the perspective of actions functions, results, assessments etc. **(E)**

Architectural Design Issues: Human Experiences

- Ethnological issues
  - Cultural preferences
  - Technological options
  - Temporal and spatial options in meeting human (stakeholder) preferences
- Stakeholder preferences
  - Functional preferences
  - Behavioral preferences and patterns
  - Cultural comfort patterns
- Structural options
  - Spatial
  - Temporal
  - Material
  - Technological design patterns

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Bible – Design in Scripture

- God creates mentioned nearly 50 times
- God forms mentioned over 175 times
- Man performs mentioned about 50 times
- Man's reflection on God's creating mentioned many times

Bible and Science

- Differences and Similarities
  - God has no bounded rationality
  - Evolution has precise meanings in engineering but vague meanings in life science
  - Science has a large spectrum of methods for analyzing and interpreting observations
  - Theology has a large spectrum of methods for analyzing and interpreting scripture.
  - Atomic invariants: Bible-the unchanging written Word of God; Science-physical matter

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Practice: Bible and Science

- Bounded Rationality
  - God and Man
- Designing Design
  - God and Man
- Good Design
- God and Man

Outline of the Talk

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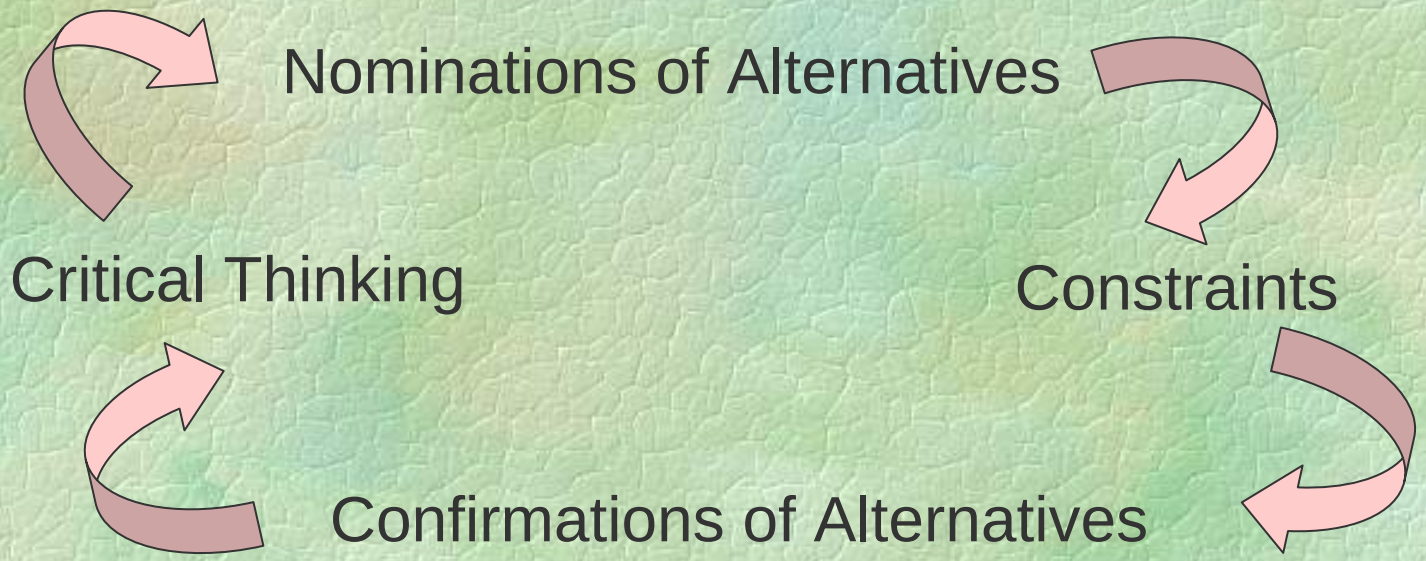
A Teaching Case

- Illustrating the Nomination and Confirmation of Design Alternatives



The Parable of the Wise Engineer

"Once upon a time there was a wise engineer, an **engineering professor** at your college…"

The engineering professor stood before his class and had some items in front of him.

The Parable of the Wise Engineering Professor

When class began, wordlessly he picked up a large empty mayonnaise jar and proceeded to fill it with rocks, rocks about 2" in diameter.

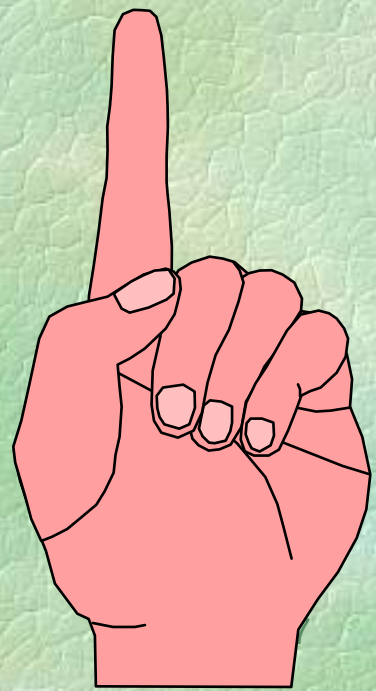
He then asked the students if the jar was full? They agreed that it was.

The Parable of the Wise Engineering Professor

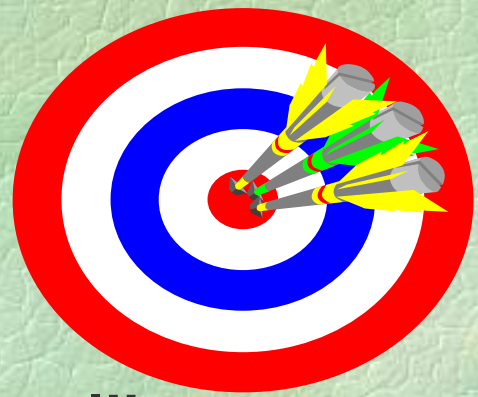
- So the professor then picked up a box of pebbles and poured them into the jar.
- He shook the jar lightly. The pebbles, of course, rolled into the open areas between the rocks.
- He then asked the students again if the jar was full.
- They agreed it was. The students laughed.

The Parable of the Wise Engineering Professor

The professor picked up a box of sand and poured it into the jar. Of course, the sand filled up everything else. "Now," said the professor, "I want you to recognize that this is your life."



The rocks are the important things - God, your family, your partners, your spiritual and medical health, your children - anything that is so important to you that if it were lost, you would be nearly destroyed.



The pebbles are the other things that matter like your job, your home, your garments. The sand is everything else. The small stuff." "If you put the sand into the jar first, there is no room for the pebbles or the rocks. The same goes for your life."

•If you spend all your energy and time on the small stuff, you will never have room for the things that are important to you.

•Pay attention to the things that are critical to your happiness. Play with your children. Take time to get spiritual and medical checkups. Take your partner out dancing.

•There will always be time to go to work, clean the house, give a dinner party and fix the disposal.

• Take care of the rocks first - the things that really matter. Set your priorities. The rest is just sand.

Lesson Learned: Designing Design

- Engineering Design
  - The Wise Engineering Professor
- Bible Lessons
  - The Parable of Jesus

Jesus:'Parable of Wise and Foolish Builders'

Luke 6:46-49 -- "…He is like a man building a house, who dug down deep and laid the foundation on rock When a flood came, the torrent struck that house but could not shake it, because it was well built …"
(instead of no foundation, on sand)
--- Rock - Jesus
--- Isaiah 28:16. Ephesians 2:19-20. Acts 4:11. 1 Peter 2:6-7

Christian Faith and Engineering Practice

- **Bible-based Christian Faith (BBCF)**
- **Design Engineering Practice (DEP)**

Comparing BBCF and DEP

BBCF

- Set Priorities

DEP

- Set Priorities

Recommending an Engineering Strategy

1. Start with a VISION

- Faith (Bible-based and Emergent Systems (Engineering-based)

2. Develop a MISSION STATEMENT

- Goals and Objectives

- Engineer an Emergent Social System whose properties as a whole,initially unknown, result in all of the components/subsystems completely and perfectly integrated into their proper structure.

3. Embrace an ARCHITECTURE

- Consider both Function and Form

- Apply Perspectives, Abstraction, and Partitions

Goal of Emergent, Engineered Systems

The Engineers' Code of Ethics

"Equipping the system developers for the building of high quality systems that will allow all people to ascend to applying the highest quality of the skills given to each, maturing to the measure of our highest potential, having the highest respect for the safety and security of all working on and using the system, so that the whole system, joined and integrated together by every structure with which it is designed, such that each part is working properly, makes system growth and evolves in the highest respect for its environment."

Do you know the origins of this old code??

Read the Letter of Paul to the Ephesians, Chapter 4: 12 - 16

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body

DEP

- Set Priorities
- Emergent System

Vision Statement

- State the vision and long term direction

Systems Engineering: What is a System?

- A purposeful collection of inter-related components working together towards some common objective.
- A system may include people, cultures, organisations, life forms, technologies, materials.
- System components are dependent on other system components
- The properties and behaviour of system components are inextricably inter-mingled

Important Examples of Systems: The Human System, and The Body of Christ

1 Corinthians 12:12 -"Just as the body is one and has many members" 27 - "Now you are the body of Christ"

Galatians 3:28 - "you are all one[in the Spirit] in Christ"

Galatians 5:22 - "the fruit of the Spirit is love, joy, peace, patience, goodness, kindness, faithfulness, gentleness, self-control

1 Corinthians 12:1 - [gifts of the Spirit] "Now concerning spiritual gifts …Now there are varieties of gifts, but the same Spirit"

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body
- Purposeful and Dependent

DEP

- Set Priorities
- Emergent System
- Purposeful and Dependent

Problems in Systems Engineering

- **Large systems are usually designed to solve 'wicked' (very complex) problems**

- **Systems engineering requires a great deal of coordination across disciplines**

  - **Almost infinite possibilities for design trade-off's across components**
  - **Mutual distrust and lack of understanding across engineering disciplines**

- **Systems must be designed to last many years in a changing environment**

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body
- Purposeful and Dependent
- Flawed and Decaying

DEP

- Set Priorities
- Emergent System
- Purposeful and Dependent
- Flawed and Decaying

Emergent System Properties

- **Properties of the system as a whole rather than properties that can be derived from the properties of components of a system**
- **Emergent properties are a consequence of the relationships between system components**
- **They can therefore only be assessed and measured once the components have been integrated into a system**

Examples of Emergent Properties

- ***The overall weight of the system***
  - **This is an example of an emergent property that can be computed from individual component properties.**
- ***The dependability (reliability) of the system***
  - **This depends on the dependability (reliability) of system components and the relationships between the components.**
- ***The usability of a system***
  - **This is a complex property which is not simply dependent on the system technology and social organisations but also depends on the system stakeholders and the environment where it is used.**

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body
- Purposeful and Dependent
- Flawed and Decaying
- Needs measured improvement in dependability

DEP

- Set Priorities
- Emergent System
- Purposeful and Dependent
- Flawed and Decaying
- Needs measured improvement in dependability

Types of Emergent Properties

- **Functional properties**
  - **These appear when all the parts of a system work together to achieve some objective. For example, a bicycle has the functional property of being a transportation device once it has been properly assembled from its components.**
- **Non-functional emergent properties**
  - **Examples are reliability, performance, safety, and security. These relate to the behaviour of the system in its operational environment. They are often critical for technology-based systems as failure to achieve some minimal defined level in these properties may make the system unusable.**

The ‘Shall Not’ Properties

- **Properties such as performance and reliability can be measured (qualitatively or quantitatively)**

- **However, some properties are properties that the system should not exhibit**
  - **Safety - the system should not behave in an unsafe way (conform to ultimate human safety standards)**
  - **Security - the system should not permit unauthorised use (conform to authority)**

- **Measuring or assessing these properties is very hard**

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body
- Purposeful and Dependent
- Flawed and Decaying
- Needs measured improvement in dependability
- Laws must be imposed

DEP

- Set Priorities
- Emergent System
- Purposeful and Dependent
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- Needs measured improvement in dependability
- Laws must be imposed

Emergent Properties of the Body of Christ

- 1 Corinthians 12:26 - “If one member suffers (e.g. Sudan), all suffer together; if one member is honored, all rejoice together”
- Ephesians 12: - “for the equipment of the saints, for the work of ministry, for building up the body of Christ, until we all attain to the unity of the faith and of the knowledge of the Son of God, to the measure of the stature of the fullness of Christ …(16) when each part is working properly, makes bodily growth and builds itself up in love”

Systems and their Environment

- Systems are not independent but exist in an environment
- System's function may be to change its environment
- Environment affects the functioning of the system e.g. system may require supplies from its environment
- The organisational as well as the physical environment may be important
- Since some environments promote system decay, systems must be stand against forces promoting decay

Emergent Systems and the Psalms

- “A Long Obedience in the Same Direction” by Eugene Peterson,Psalms 120-134, Psalms (Songs) of Ascent
- System ‘”A purposeful collection of inter-related components working together towards some common objective.”
- In Engineering an Emergent System is a system whose properties as a whole are unknown until all of the components/subsystems are completely and perfectly integrated into their proper structure.

Comparing BBCF and DEP

BBCF

- Set Priorities
- Emergent Body
- Purposeful and Dependent
- Flawed and Decaying
- Needs measured improvement in dependability
- Laws must be imposed
- A plan for improvement is needed

DEP

- Set Priorities
- Emergent System
- Purposeful and Dependent
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- A plan for improvement is needed

System Evolution: Planned or Random?

- **Large systems should have a long lifetime. They must evolve to meet changing requirements**
- **Evolution is inherently costly**
  - **Changes must be analysed from a technical and business perspective**
  - **Sub-systems interact so unanticipated problems can arise**
  - **There is rarely a rationale for original design decisions**
  - **System structure is corrupted as changes are made to it**
- **Existing systems which must be maintained are sometimes called legacy systems**

Goal and Objective

- **State the desired goal - to evolve emergent systems so that they are dependable (safe, secure, reliable, available) and all of the components/subsystems are completely and perfectly integrated into their proper structure.**
- **State the desired objective**
- **Use multiple points if necessary**

What about Evolution?

- 'Evolution' is a process of development wherein gradual change takes place. We may speak of evolution of, for example, social, economic, software or engineering structures.
- "In the beginning God created [began to create] the heavens and the earth.": Genesis
- "All plans are computable .... and therefore random sequences do not exist.":Computer Science
- Is evolution random or planned?

What about Evolution?

- **D. Knuth, a famous computer scientist and applied mathematician at Stanford University, proved in the 1960s that the assertion of a random sequence is, indeed, not well-defined. The general idea is that if a random sequence were to exist then it would be computable. But if it is computable then it has a plan. Therefore, it cannot be random.**
- **The engineering alternative is now the accepted concept of pseudo-randomly generated sequences having measured degrees of complexity**

Today's Situation - "What is!!"

- **Summary of the current situation**

- **A System that decays: has a short life-time, cannot meet human expectations, cannot be maintained, becomes unreliable, becomes unavailable, becomes undependable - true of most man-made systems**

- **Random evolution cannot prevent decay**

How Did We Get Here?
"Remember the history!!"

- **Any relevant historical information: all software systems decay; USA is completely dependent on software**

- **Original assumptions that are no longer valid: science and technology will eventually prevent the decay of human-made systems such as software**

If we forget our History!

First they came for the Jews
And I did not speak out –
Because I was not a Jew.

Then they came for the communists
And I did not speak out –
Because I was not a communist.

Then they came for the trade unionists
And I did not speak out –
Because I was not a trade unionist.

Then they came for me –
And there was no-one left
To speak out for me.

Pastor Niemöller, 1938

Good Engineers Always

- **Remember and tract a system's history to remember what causes decay**
- **Remember how to measure and improve the quality of the system**
- **Remember how to build the system so that it will not decay**

Available Options

- **Alternative strategies: Improved Engineering Process Models. Improved Design Structures.**
- **List advantages & disadvantages of each**
- **State cost of each option**
- **Possible operational concept models: forget about system history and do what seems right at the time; keep accurate documents of system history and follow a good emergent system plan**

We Need A Plan!!!

God's Plan

- God's Purpose: Peace and Life (No Decay)
- Our Problem: Separation (Decay)
- God's Remedy: The Cross (save us from Decay)
- Our Response: Receive Christ (and retire that old system!)

Man's Plan

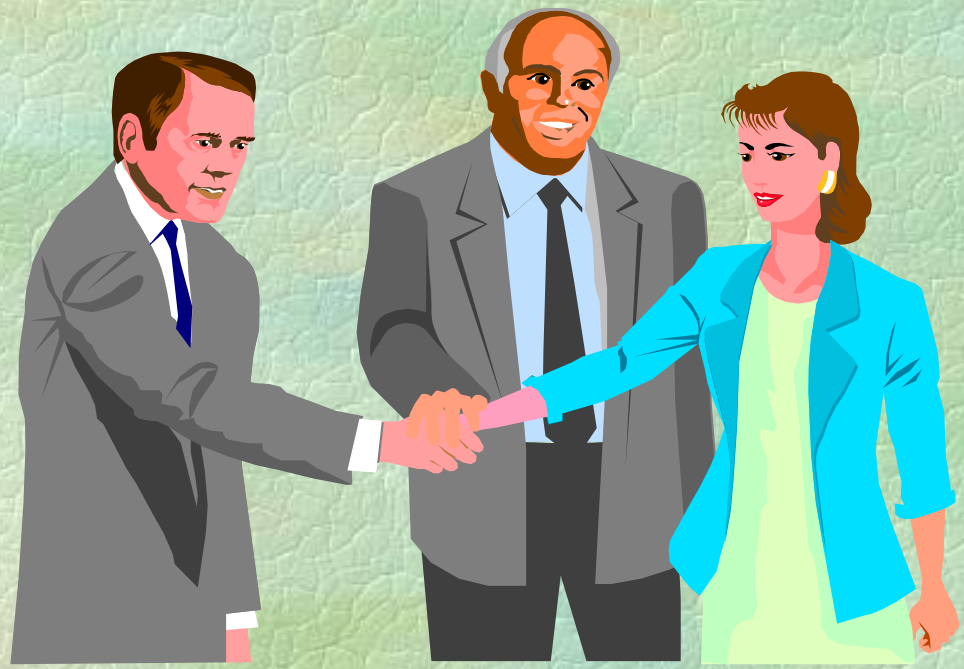
- Man's Purpose: Depends on to whom you talk? It's relative
- Our Problem: All our systems keep decaying
- Our Remedy: Depends on to whom you talk? It's relative
- Our Response: You've got a choice between systems developers - time to look into procurement!

Recommendation

- **Recommend one or more of the strategies: God's or Ours**
- **Summarize the results if things go as proposed: Life or Decay**
- **What to do next: Feasibility Study?**
- **Identify Action Items: Decision Time!**
- **Commands of God!**

Time to get those standards manuals out again! Professional Ethics and Christianity

- **IEEE Code of Professional Ethics**
- **ACM Code of Professional Ethics**
- **The Ten Commandments**
- **The Golden Rule**
- **The Great Commandments**



“I hope we made the right decision!”