Create a Concept Architecture

M. Thangavelu
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and The School of Architecture
ASTE527
What it is not about
What it is not About

• SysML
• Model Based Systems Engineering
• IPPD
• Object Oriented Programming
ALTERNATE CONCEPT GENERATION IS FASTER, CHEAPER, BETTER

- from need and requirements it is possible to conceive rudimentary solutions
- spend more time exploring alternative concepts
- failure at conception stage in project realization is acceptable nay, it is even desirable!
- This is the last stage where mistakes will not cost a lot!
- In fact, exploring several concepts could save resources by indicating choices that are clearly superior very early during project evolution.
Louise Bourgeois Fillette – Peter Zumthor
Civil Architects Imagine and Create ‘em Darn’dest....thingys !
Druids and Engineers

There are two kinds of fools: one who says this is old and therefore good, and the other who says this is new and therefore better. The argument between the two is as old as humanity itself, but technology's relentless exponential advance has made the divide deeper and more contentious than ever. My greatest fear is that this divide will frustrate the sensible application of technological innovation in the service of solving humankind's greatest challenges.

The two camps forming this divide need a name, and "Druids" and "Engineers" will do. Druids argue that we must slow down and reverse the damage and disruption wrought by two centuries of industrialization. "Engineers" advocate the opposite: we can overcome our current problems only with the heroic application of technological innovation. Druids argue for a return to the past, Engineers urge us to flee into the future.
To this one question, variously expressed, I sought an answer in science. And I found that in relation to that question all human knowledge is divided as it were into two opposite hemispheres at the ends of which are two poles: the one a negative and the other a positive; but that neither at the one nor the other pole is there an answer to life's questions. The one series of sciences seems not to recognize the question, but replies clearly and exactly to its own independent questions: that is the series of experimental sciences, and at the extreme end of it stands mathematics. The other series of sciences recognizes the question, but does not answer it; that is the series of abstract sciences, and at the extreme end of it stands metaphysics.

“See that you remember”. And I awoke.
Claude Shannon
What I cannot create, I do not understand.

Know how to solve every problem that has been solved.

Why cost $ \sqrt{\text{yet}} \cdot \text{PC}

To learn:
- Bethe Ansatz Prob.
- Kondo
- 2-D Hall
- Area, Temp.
- Non Linear Classical Hydro
What it IS about
Create A Concept
Scope

• ASTE527 History
• Course Purpose
• Concept Creation Principles
• Examples
• ASTE 527 Site :
  https://sites.google.com/a/usc.edu/aste527/home
ASTE527- Space Exploration Architectures
Concept Synthesis Studio

A Bit of History

• Eb Rechtin SAE Program at USC 1988
• MALEO thesis Example
• Curriculum Development – Arch + Engg
• AE to AME to Architecture to ASTE
• ASTE Department offers a 3 unit elective
ASTE 527 Goal

- Brainstorming for ideas
- Out-of-the-Box thinking
- Synthetic thinking v Analytical
- Bringing together to create something useful
- Art more than Science
- Creativity
- Imagination
Creative Processes

- Darwinian Evolutionary Process
- Random Walk
- Recursive
- Monte Carlo Method
- Julia & Mandelbrot sets
- Markoff Chain
- Iowa Writers Workshop – be inquisitive, inclusive
- Learn by “Pranging”
ASTE 527 Examples

- MALEO
- NOMAD Explorer
- Lunar Cycler - MOBIUS
- Lunar SuperComputer
- 3D Food for Space Missions
- Planetary Defense Moon
- ISS Commerce - Orbiting Hotels
- Lunar Agriculture
- SARA
- MOBIUS
Module Assembly in LEO (MALEO)
Lunar South Polar Landing Pad
Lunar Agriculture
Planetary Defense from our Moon
Lunar Orbiting Lounge
Lunar SuperComputer
3D Food for Space Missions
Create a Concept Architecture

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Why Concept Creation?

• One of the important tasks of the System Architect
  – Providing alternative choices to the client
  – In a timely manner
  – Back office IR&D

• Choices allow planners to plan, pick and choose between options in a dynamic environment

• Biggest Blunders are Made on First Day
Unleash Imagination
Constraints

• Every tool, every process constrains or dictates human imagination
• Computers, software and user interfaces (top level architectures) all conspire to channel and restrain creativity in specific ways.
• How to unleash human imagination?
• Human mind, free of tools, is the ...
• Ultimate Imagination Machine
Operating Domain

• Need
• Imagination
• Creativity
• Innovation
• Knowledge
Knowledge is the Fruit of Imagination

Quote Transmission 001: Einstein and Imagination

“Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand.”

- Albert Einstein
Imagination

- Exercise in Imagination
- Exercise in Creativity
- If you can dream it, you can build it
- Vision
- Objective Oriented
- "You Can’t Depend On Your Eyes or Judgement When Your Imagination Is Out of Focus"
YOU CAN’T USE UP CREATIVITY THE MORE YOU USE THE MORE YOU HAVE

Maya Angelou
Imagination process is not A Structured Method
Creative Brain
The Brain

- Amazing Organ
- Complex System
- Ability to Create
- Synthetic Function
- Math and Science as Art Forms
- Science and Technology as Art of the Times
- Plasticity
The Corpus Callosum
Communicate

• Many dynamic parameters
• Changing Context
• Anticipate
• Communicate Vision
• Update Vision
• Tweak and Share Vision regularly – Bezos, Jobs
• Build Common Model
ALTERNATIVE ENGINEERING CONCEPT GENERATION AND REFINEMENT IS AN ITERATIVE PROCESS

CONCEPTION

SYNTHESIS

VERIFICATION

ANALYSIS

NO

YES

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M.THANGAVELU USC 93
AVOID TUNNEL VISION SYNTHESIS

need

analysis
requirements
program
development

concept 1

verify?

concept 1

concept evolution timeline

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Beware the Credibility Downhill Slope!
Concept
Architecture
Pointers
The Nature of Complex Projects

- Wicked Problem
- Dynamic and fast changing Context
- Parameters change
- Need to keep up with many variables
- Many times solved “out of bounds”
- Many times solved by introduction of new parameters
- Rapid Creation - Seize the opportunity
Create Alternative Concepts

- **International Space Station**
  - Several iterations
  - Several incarnations
  - Global Political solution

- **STS Space Shuttle**
  - Several Concepts
  - Economic Solution

- **Apollo**
  - Several Concepts
  - Lunar Rendezvous
What is a Concept Architecture?

- A simple way to project an idea for a complex project
- Elevator Pitch
- Give idea a storyline
- Make it a story
- Credibility counts!
- Present it as a Set of slides
- 10 minutes – 15-20 slides Max
Create a Concept - Steps to Follow

• Catchy Title
• **Context** – Current or near term, avoid warp speed other fantastic stuff
• **Problem** - Define/Bound Need
• **Rationale** - Make and support it
• **Assumptions** and Ground Rules – Establish & Bound it
• **Concept** – this is where you spend your time
• **Merits and Limitations**
• **Future Studies**
• References
• Backup Slides
The Philosophy

- Architect first
- Engineer next
- Just like you build a home
- Create alternative concepts
- Pitch them against each other
- Develop hybrids
- Propose strong-boned concepts
- Solve wicked problems “out of bounds”.
The Process

• Create Alternative Ideas
• Pre Proposal Phase
• Pre Engineering
• Create the Concept first
• Architect first
  – Program development, qualitative
• Engineer it next
  – Analyses, trades
The Process

• Start in your area of Expertise
• Use Associative Logic
• Make Connections
• Visualize
• Sans Show Stoppers
• Complete the Process
• Tweak and
• Repeat
Create a Concept - Steps to Follow

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• **Merits and Limitations**
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Architecting vs. Engineering

• Architecting is a qualitative process
• Engineering is a quantitative method
• Architecting addresses – why, what, when, where
• Engineering defines and bounds – how, how much?
• Architect first, engineer next
• Concept Creation is an up front, top level, Architecting process - Synthesis
• It creates a range of choice for the client
• Create first, Optimize later
Architecture & Engineering

Synthesis Oriented
Design Visualization
Graphics

Analysis Oriented
Trades
Numbers
The Wicked Problem

- Complex problem
- One of a kind
- Not cookie cutter
- Many dynamic variables
- Moving goal posts
- Introduce new parameters
- Solved “out of bounds”
Tools

• Context – Sense and Sensitivity
• Associative Logic - Connections
• Lateral Thinking
• Analogies
• Intuition – Lessons Learned – Experience
• Heuristics
• Imagination
• Creativity
Priming the Mind

• Plug into data stream
• Chaos
• Lot of noise
• Input parameters
• Include Conflicts
Creative Synthesis - Hegel?

- Thesis, Antithesis – Synthesis
- Human Connectome Project
- The conflict between what is ideal or impossible and that which is possible is essential for creative synthesis
"There’s a tension between feasibility and desirability," Thangavelu said. "But the conflict between what’s possible and what’s daydreaming is necessary to arrive at creative, passionate solutions."
MOBIUS

Supersynchronous Earth Orbits for Lunar Missions
(An Evolutionary Strategy for Lunar Tourism)

Madhu Thangavelu
ASTE Department, Viterbi School of Engineering
University of Southern California

AIAA Space Conference, Long Beach CA, 2016
USC Astronautical Engineering

Students pursuing MS ASTE through DEN in 2005–2014

Also in Canada (Ontario and Quebec) and various military installations abroad

Master of Science in Astronautical Engineering (MS ASTE)
ASTE 527 Space Concepts Studio

- Since 1993
- 3-unit elective modeled after Architecture Design Studio
- Focus on Concept Creation
- Rapid Complex Ideation
- Architecture + Engineering tools
- No time for engineering optimization rigor
- Concepts help planners make choices - may or may not work, expands breadth of investigation
Borrow from other professions that deal with complex “wicked” problems
Solve using “out of bounds” approach
Associative Logic
Connections
Case Studies
Lectures from creative professionals
Iterative process – till you get it right!
Sandbox for creativity – Writer’s Workshop
ASTE 527 Graduate Space Concept Synthesis Studio Web Site

- https://sites.google.com/a/usc.edu/aste527/home
Figure 2

Baseline Scenario

If NASA continues its business as usual without a major increase in its budget and without using nonterrestrial resources as it expands into space, this is the development that might be expected in the next 25 to 50 years. The plan shows an orderly progression in manned missions from the initial space station in low Earth orbit (LEO) expected in the 1990s, through an outpost and an eventual space station in geosynchronous Earth orbit (GEO) (from 2004 to 2012), to a small lunar base in 2016, and eventually to a Mars landing in 2024. Unmanned precursor missions would include an experiment platform in GEO, lunar mapping and exploration by robot, a Mars sample return, and an automated site survey on Mars. This plan can be used as a baseline scenario against which other, more ambitious plans can be compared.
ISS Future

- End of mission 2024
- NASA Plan – Deorbit
- ISS Consortium
- Send to Moon
- Some Alternatives
  - Bring more partners into program
  - Turn over to private sector
  - Historical Artifact - Park in high orbit
  - Disassemble and bring back to Earth
Evolution of ISS as Spacecraft Integration Platform

- Original purpose
- Repurpose - Gerstenmaier
- Commercial Use
- Large Spacecraft assembly - MALEO – ISU 1988
- USC Space Concept studies – Evolution of ISS 1&2
- https://sites.google.com/a/usc.edu/aste527/home
- International Space Transit Vehicle
- Cosmic Mariner
Space Exploration Initiative [SEI]
1. Payload delivered to Space Station Freedom
2. Mars transfer vehicle mated with payload at Freedom
3. Trans-Mars phase with Mars transfer vehicle
4. Mars transfer vehicle remains in Mars orbit; Mars excursion vehicle descends to surface
5. Excursion vehicle to/from Mars surface
6. Trans-Earth phase with transfer vehicle
7. Transfer vehicle aerobrake maneuver and return
8. Elliptical Orbit
9. Mars excursion vehicle separates and arrives 1 day before Mars transfer vehicle
MALEO : MODULE ASSEMBLY IN LOW EARTH ORBIT

A strategy to build and commission a lunar surface habitat complex by integrating several modules in LEO using the ISS and her crew, and ship it to the lunar surface using custom propulsion systems, thereby avoiding the infrastructure otherwise needed to construct one piece by piece, and eliminating the clingy dust nuisance that hampers lunar surface activity.

First proposed at the inaugural summer session of the International Space University at MIT in 1988

First presented and published at the 1988 IAC in Bangalore, India

MALEO - SALIENT FEATURES

- Payload Summary [MT]
- Habitat Module = 15
- Lab Module = 15
- Power/Logistics = 15
- ECLSS Node = 5
- Sanitation/Hygiene = 5
- Airlock/EVA = 10
- Truss/Landing gear = 10
- 100kW Solar Arrays/Comm = 5
- Unpress. Electric Rover X2 = 10
- Attitude Control Pallet X3 = 6
- Touchdown Mass ~100MT
- + lander propulsion stack
MALEO Assembly with ISS Crew – Note SpaceX Dragon
MALEO Lunar Deorbit & Landing
Earth Station: 
Global ISS Marketing 
Future of Human Spaceflight 
A Lunar Cruise

Michael Barrucco
1. Launch from Wallops (US), Baikonur launch (Russia), Jiuquan Satellite Launch Center (China)
2. Dock with ISS during sunrise
3. Coast for 2-3 days until next TLI opportunity
4. TLI-3107 m/s
5. Trajectory correction ~80 m/s
6. Coast for ~7 days View Starfields, and Heritage Sites
7. LOI~700 m/s

To the Sun
- TEI Day 11
- Moon re-aligned with ISS Orbital Plane

- Moon at EOI
- ISS Nodal Regression 5° per day

- LOI Day 4
- Moon aligned with ISS orbit plane

- TLI from ISS

2nd Cycle

7 day cruise in orbit

Cis-Lunar Cruise
International Space Transit Vehicle – Roukos/Thangavelu 2010
International Space Transit Vehicle – Roukos/Thangavelu 2010
Evolution of the Space Cruise Ship “Cosmic Mariner”

Edmundson, P. & Thangavelu, M.
Main Elements

- Laboratory/Medical Module
- Bioregenerative Life Support System Module
- Power and Control Module
- Node
- Nuclear Electric Propulsion Module
- Robotic Arms
- Habitation Module
- Solar Arrays
- Radiators
Future Evolution

Expansion to accommodate 50 passengers for travel in cislunar space by 2030
Future Evolution

Expansion to accommodate 100 passengers for interplanetary travel by 2050
Follow-on Missions

Support of Space-Based Solar Power Satellite Construction
Follow-on Missions

Exploration of Near-Earth Asteroids
Cislunar Orbits

- Free Return
- Halo
- Lagrange
- Weak Stability Boundary
- Backflip
- Frozen Orbits
- Resonant Orbits
- Cycler
Apollo Free Return Trajectory
LUNAR SALVAGE MISSION
ORBITAL TRAJECTORIES

Post lunar fly-by
Earth perigee
May 16, 11 pm EDT
42,000 km

Trans-lunar injection
May 7, 9 pm EDT

Final geosynchronous orbit
Late May
36,000 km altitude

April 28, 1 am EDT
214,000 km

May 4, 1 am EDT
321,000 km

5 3/4 days to moon

3 1/4 days return to Earth

MOON

Perilune
May 13, 4 pm EDT
8000 km
HGS-1 2nd LUNAR FLYBY
ORBITAL TRAJECTORIES

1st lunar encounter
May 13, 4 pm EDT
6200 km altitude

2nd lunar encounter
June 6, 12 pm EDT
36,000 km altitude

May 24, 11 pm EDT
488,000 km

5
2nd lunar encounter
June 6, 12 pm EDT
36,000 km altitude

MOON

EARTH

1
1st lunar encounter
May 13, 4 pm EDT
6200 km altitude

2
May 16, 11 pm EDT

3
May 24, 11 pm EDT
488,000 km

4
June 1, 11 pm EDT

5
2nd lunar encounter
June 6, 12 pm EDT
36,000 km altitude

6
June 14, 5 pm EDT

7
Final geosynchronous orbit
June 16

Hughes Global Services
Supersynchronous Earth Orbit

- Beyond GSO
- High Eccentricity
- Resonant Period Design
- Cycler
MOBIUS
An Evolutionary Strategy for Lunar Tourism

Mehdi Lali, Madhu Thangavelu
ASTE Department, Viterbi School of Engineering
University of Southern California

AIAA Space Conference, Long Beach CA, 2016
Mission Elements

Quartet of Resonant Supersynchronous Orbits

Starting point

3.5

28

24.5

21

17.5

7

10.5

14

supersynchronous orbit

MOBIUS mission scenario
MOBIUS Rationale

- Space Activity as opposed to Space Exploration
- Self-Sustainable Space Architecture
- Revenues from Missions used to fulfill Objective
- Use ISS beyond Retirement 2024

- Incremental Approach
  - Phase 1 - lunar approach
  - Phase 2 - lunar orbit
  - Phase 3 - lunar landing
Mission Elements

Cislunar Transit Orbit (CTO)

Edge-on illustration of MOBIUS Cislunar Transit Orbit (CTO)

Rp = 15,000 km
Ra = 300,000 km
Δi = 28.120 deg.
Δv = 2.98 km/s required for plane change

apogee
moon landing trajectory
transit hotel
super-synchronous orbit (moon coplanar)
ISS orbit
perigee
cis-lunar bus (COV)
earth equator

23.44°

not to scale

5/2/2017
Madhu Thangavelu FISO Seminar
Mission Elements - Earth-Moon Supersynchronous Orbit

- **Cislunar Transit Orbit (CTO)**

  - Moon's inclination = 22.7162°
  - Sun's true latitude = 282.87°
  - Moon's true latitude = 109.35°
  - Cp = 15120 km
  - Ra = 299880 km

Moon & S/C's positions in January 1, 2016 (UTC=00.00.00)
Concept

Deployment of un-crewed COV to final orbit

- Moon
- Landing trajectory
- Ascent trajectory
- L1
- Apogee
- Final orbit
- Transfer orbits
- COV (lunar bus)
- Inner Van Allen radiation belt
- Inbound
- Outbound
- Outer Van Allen radiation belt
- Perigee
Concept
Perigee Rendezvous
Concept
Apogee Rendezvous

Lunar Transit Lounge (LTL) at L1
SOI
dockling capsule
apogee
undocking capsule
inbound
Cislunar Orbital Vehicle (COV)
outbound
The main elements of the proposed mission design architecture are as follows:

- International Space Station (ISS)
- Cislunar Orbital Vehicle (COV)
- Tourist Docking Capsule (TDC)
- Cislunar Propulsion System (CPS)
- Lunar Transit Lounge (LTL)
- Lander
- Lunar surface facilities
MOBIUS Mission Elements

Orion / Dragon / New Glenn

Lunar Transit Lounge

Commercial ISS

Upper Stage

Lunar Lander
Earth-Moon Transfer Orbit Habitat

Cislunar Orbital Vehicle (COV)
Mission Elements

COV interior cutaway

2D schematic of COV interior design
Capsule departs from the ISS
Concept

Capsule departs from the ISS
Concept
Capsule is about to dock with COV
Capsule is docked with COV.
Concept

Ready for Cislunar Injection (CLI)
Concept

On its way …
Concept
Apogee Rendezvous

Transferring passengers to LTL
Concept
Apogee Rendezvous

Lunar Transit Lounge (LTL)
Merits & Limitations

- Optimal
- Affordable
- Feasible with current technologies
- Viable
- Free Return Trajectory- If there is an injection anomaly, the vehicle stack will return to Earth orbit without help for abort.
Merits & Limitations

- Evolutionary, phased approach-maximize revenue operating budget.
- Requires a little station-keeping due to RAAN precession over time.
- Plane change at perigee can be costly unless ISS’ inclination is changed after retirement to be aligned with that of the Moon.
- Earth’s Van Allen Belt could be challenging so proper shielding is essential.
Questions, Comments?

Welcome to the future of lunar tourism!

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Evolution - From Here to There Before
Acknowledgement

- This concept was developed by Mehdi Lali, graduate student in the ASTE527 Graduate Space Architecting Studio (aka Space Concepts Creation Studio) in Department of Astronautical Engineering within the Viterbi School of Engineering at USC. Studio slides may be accessed at:

  https://sites.google.com/a/usc.edu/aste527/home

- Look under team project “LunaRevolution”
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OST Inc., http://www.ostinc.com/#!rocketost/c1vw1


Philosophy, Visions, Policies, Architectures, Concepts, Engineering
ALTERNATIVE ENGINEERING CONCEPT GENERATION AND REFINEMENT IS AN ITERATIVE PROCESS
T.E. Lawrence

• All men dream, but not equally. Those who dream by night in the dusty recesses of their minds, wake in the day to find that it was vanity: but the dreamers of the day are dangerous men, for they may act on their dreams with open eyes, to make them possible.
Education

• We focus on being right and proper
• We focus on being perfectly correct
• We focus on facts and application of laws.
• You can't depend on your judgment when your imagination is out of focus.
• Wish we focused more on imagination
Architecting vs. Engineering

• Architecting is a qualitative process
• Engineering is a quantitative method
• Architecting addresses – what, when, where
• Engineering defines and bounds – how, how much?
• Architect first, engineer next
• Concept Creation is an up front, top level, Architecting process - Synthesis
• It creates a range of choice for the client
• Create first, Optimize later
The Wicked Problem

• Complex problem
• Many dynamic variables
• Moving goal posts
• Introduce new parameters
• Solved “out of bounds”
Heuristics

- Murphy’s Law
- Parkinson’s Law
- Augustine’s Laws
- Akin’s Laws
- Surgeon’s Heuristic - The eye cannot see what the mind cannot comprehend.
Critical Skill - Connections

- Synthetic Intelligence
- Context and Associative Logic
- Looking for Patterns
- Apply Heuristics
- Quilting
- Common Model – Debate and Discussion
Engineering is not Abstract, not Cerebral – It is Physical

- Francis Bacon – Chicken experiment
- Hooke and Newton
- “Pranging” is the name of the game
Spaceship Earth – Buckminster Fuller
New Space Paradigms

- Musk – Settle other planets – human survival insurance
- Bezos – Protect and make Earth beautiful
- Marburger III – Economic sphere of influence
- Campbell - Return of the Hero
- Dyson – Beautify our Universe
- Frank White – Overview Effect
IRRADIATING FOOD TO PERFECTION

Grilling food over an open flame is a practice as old as humanity itself. Indeed, it’s likely that we are human precisely because we learned to grill our food. Perhaps it is this primal connection that makes grilled foods such as hamburgers so mouth-watering; we’re hard-wired by evolution to find comfort in the heat of the grill, the smell of the smoke, and the taste of the food. Although grilling food is so simple that our ancestors managed to do it eons ago, mastering the heat of the grill is a culinary challenge of the highest order.

A layer of ash should coat the coals before food goes on the grill. The ash shields the coal’s glow, moderating the heat they radiate. The ash also reduces the chimney effect by insulating the coals from the air.

Food must be relatively thin to cook properly in the intense radiant heat and convection air coming from the coals. Food that is too thick will burn on the outside before heat can penetrate to its core.

Waiting smoke gives form to the turbulent air thatescape slumber past the patios, much like what happens in a chimney. Heat from the burning fuel causes adjacent air to expand, making it more buoyant. As the hot air rises, it cools the food and creates a draft that sucks more air in to fuel the fire.

Grills are definitely not nonstick surfaces. The high temperatures at which charcoal grills operate would make most nonstick coatings unsuitable. Coating food in oil works, but can cause flare-ups that coat the food with soot. The best way to avoid sticking is to presoak the grill with a patina made with a liquid cast iron or steel works (see How to Season a Wok, page 33).

Smoke may seem to flicker above charcoal, but these fiery tongues are actually little plumes of incandescent carbon soot. The superheated air in turbulent convection puffs up small pieces of the coals and allows them to react with carbon dioxide in the air to produce carbon monoxide. The flammable monoxide burns with a hot but faint blue flame at 1,600 °C (2,900 °F) or higher, which heats the coal particles so much that they glow with an intense white light that masks the dim fire from the monoxide.

Glowing coals generate temperatures well above the 720 °C (1,300 °F) required for mild light in the visible part of the spectrum. The bright orange light emitted by the center of the embers indicates a temperature above 3,900 °C (7,000 °F). Pockets between the coals are hotter still; there, burning carbon monoxide heats soot to at least 1,400 °C (2,550 °F).
On whether we are capable as a species of tackling climate change: I don't think we're yet evolved to the point where we're clever enough to handle a complex a situation as climate change. We're very active animals. We like to think: "Ah yes, this will be a good policy," but it's almost never that simple. Wars show this to be true. People are very certain they are fighting a just cause, but it doesn't always work out like that. Climate change is kind of a repetition of a war-time situation. It could quite easily lead to a physical war. That's why I always come back to the safest thing to do being adaptation. "I've always said that adaptation is the most serious thing we can do"
Mohandas Gandhi

Seven Deadly Sins Wealth without work Pleasure without conscience Science without humanity Knowledge without character Politics without principle Commerce without morality Worship without sacrifice.

— Mahatma Gandhi —
Today's scientists have substituted mathematics for experiments, and they wander off through equation after equation, and eventually build a structure which has no relation to reality.

Nikola Tesla
“It is the tension between creativity and skepticism that has produced the stunning and unexpected findings of science”

Carl Sagan
Creative Synthesis - Hegel?

- Thesis, Antithesis – Synthesis
- Human Connectome Project
- The conflict between what is ideal or impossible and that which is possible is essential for creative synthesis
There’s a tension between feasibility and desirability," Thangavelu said. "But the conflict between what’s possible and what’s daydreaming is necessary to arrive at creative, passionate solutions."
Be Wary of Riding A Dead Horse

• Riding a Dead Horse
• The tribal wisdom of the Dakota Indians, passed on from generation to generation, says that –

• when you discover that you are riding a dead horse, the best strategy is to dismount.
THE DEAD HORSE THEORY

The tribal wisdom of the Dakota Indians, passed on from generation to generation, says that, "When you discover that you are riding a dead horse, the best strategy is to dismount."

However, in modern business, education and government, a whole range of far more advanced strategies are often employed, such as:

1. Buying a stronger whip.
2. Changing riders.
3. Threatening the horse with termination.
4. Appointing a committee to study the horse.
5. Arranging to visit other countries to see how others ride dead horses.
6. Lowering the standards so that dead horses can be included.
7. Re-classifying the dead horse as "living impaired".
8. Hiring outside contractors to ride the dead horse.
9. Harnessing several dead horses together to increase the speed.
10. Providing additional funding and/or training to increase the dead horse's performance.
11. Doing a productivity study to see if lighter riders would improve the dead horse's performance.
12. Declaring that as the dead horse does not have to be fed, it is less costly, carries lower overhead, and therefore contributes substantially more to the bottom line of the economy than do some other horses.
13. Re-writing the expected performance requirements for all horses.
14. Promoting the dead horse to a supervisory position of hiring another horse.
Advanced Medicine - Transplants
Nobel Prize in Physiology or Medicine 1960

- Peter Brian Medawar (1/2)
- Discovery of acquired immunological tolerance
  - The graft reaction is an immunity phenomenon
  - 1950s, induced immunological tolerance to skin allografts in mice by neonatal injection of allogeneic cells

Great events in history of transplantation
Surgeon’s Heuristic - Robertson Davies Corollary

The eye cannot see what the mind cannot comprehend
Arthurg C. Clarke

“The only way of discovering the limits of the possible is to venture a little way past them into the impossible.”

- Arthur C. Clarke
Lesson from Scriptures

- Brahma - Generator
- Vishnu – Operator
- Shiva – Destroyer/Transformer
Philosophy, Visions, Policies, Architectures, Concepts, Engineering
“Whoops—I accidentally pressed ‘elevator pitch.’”
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