BEYOND THINKING OUTSIDE THE BOX

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INCOSE Tutorial – Chesapeake Chapter

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BEYOND TOTB – For Systems Engineers and Entrepreneurs

- **This Tutorial extends a previous presentation and discussion of Thinking Outside the Box. It explores a variety of ways of thinking that have been especially useful for systems engineers and entrepreneurs. Specific areas to be explored include systems thinking, reductionism, lateral thinking, expanding dimensions, design thinking, crossover, disruptive thinking, generalization, thinking through pictures, functional decomposition, the morphological box, and others. The Tutorial is drawn from an 8-week course given by Dr. Eisner last year as part of the OLLI (Osher Lifelong Learning Institute) Program**

BRIEF BACKGROUND – Dr. Howard Eisner

- - Retired as professor emeritus in 2013, Eng. Mgmt & SE Dept., SEAS, GWU
- - Prior 30 years in Industry; Pres. of Intercon Systems & Atlantic Research Services Corp.
- - Life Fellow of IEEE; Fellow of INCOSE and the NY Academy of Sciences
- - Member: Tau Beta Pi, Eta Kappa Nu, Sigma Xi, Omega Rho
- - Selected Books:
- — Computer-Aided Systems Engineering, Prentice-Hall, 1988
- — Essentials of Project and Systems Eng'g Mgmt, John Wiley, 1997, 2002, 2008
- — Reengineering Yourself and Your Company, Artech House, 2000
- — Managing Complex Systems – Thinking Outside the Box, 2005
- — Systems Engineering, Morgan & Claypool, 2011
- — Topics in Systems, Mercury Learning & Information, 2013
- - BEE, CCNY ('57); MS, Columbia University ('58); Doctor of Science, GWU ('66)

"INSIDE THE BOX" - 1 WHAT'S OUTSIDE?

- 1. APPROACH 100% INTEGRATION OF ALL STOVEPIPES
- 2. "BEST OF" BEST OF BREED IS THE OPTIMAL APPROACH
- 3. MEASURE AS MUCH AS YOU CAN THINK OF
- 4. ADD MORE PEOPLE TO GET BACK ON SCHEDULE

"INSIDE THE BOX" – 2 WHAT'S OUTSIDE

- 5. ACCEPT REQUIREMENTS FROM CUSTOMER AS FIXED AND INVIOLATE
- 6. PROMISE WHATEVER THE CUSTOMER APPEARS TO WANT
- 7. ALL LEVELS OF MANAGEMENT NEED DOLLAR RESERVES
- 8. GET IT RIGHT THE FIRST TIME (CROSBY – DIRFT)

"INSIDE THE BOX" – 3 WHAT'S OUTSIDE?

- 9. GET THE PROCESS RIGHT AND THE PRODUCT WILL ALWAYS BE RIGHT
- 10. DON'T DO WORK UNLESS YOU SEE IMMEDIATE PROFIT FROM IT
- 11. ALL SYSTEMS SHOULD BE ARCHITECTED USING THE DODAF APPROACH
- 12. THERE IS NO OVERALL APPROACH (NO SILVER BULLET) THAT WILL "SOLVE" THE SYSTEM ACQUISITION PROBLEM

ORIGINAL PERSPECTIVES
(5 OF 9 WAYS TO TOTB)

- 1. BROADEN AND GENERALIZE
- 2. CROSSOVER
- 3. QUESTION CONVENTIONAL WISDOM
- 4. BACK OF THE ENVELOPE
- 5. EXPAND THE DIMENSIONS

BROADEN AND GENERALIZE (CONT.)

- FUNCTIONAL DECOMPOSITION – LOOK SIDEWAYS, UP AND DOWN
- USING FORMAL ALTERNATIVES AS A WAY OF ARCHITECTING
- EXAMPLE: FDM or TDM
- SIMPLY ADD FUNCTIONS – WHAT HAPPENED TO THE PDA/PHONE?

ORIGINAL PERSPECTIVES
(WAYS 6-9 TO TOTB)

- 6. "OBVERSITY"
- 7. REMOVE CONSTRAINTS
- 8. THINKING WITH PICTURES
- 9. THE SYSTEMS APPROACH

2. CROSSOVER

- BUILD SYSTEM(S) IN ONE DOMAIN, APPLY IN SEVERAL
- CREATES ENORMOUS LEVERAGE
- REUSE – SOFTWARE
- DEVELOPER OFF-THE-SHELF (DOTS) SYSTEM
- MODELS AND SIMULATIONS
- ACCOUNTING FIRMS

1. BROADEN & GENERALIZE

- THE RAILROADS (Strategic Planning)
- SYSTEM OF SYSTEMS ENGINEERING
- SOME EXAMPLES
- -- IBM
- -- MICROSOFT
- -- HALOID
- -- WANG LABS

3. QUESTION CONVENTIONAL WISDOM

- HALOID, AGAIN
- NATIONAL MISSILE DEFENSE (Hit a Bullet With a Bullet)
- NORMAN AUGUSTINE
- DR. DEMING
- NEW "PARADIGMS"
- -- DRUCKER'S MBO
- -- PETERS & WATERMAN (ISO EXCELLENCE)
- -- KAPLAN & NORTON (SCORECARD)
- -- GOLEMAN'S EMOTIONAL INTELLIGENCE
- -- SENGE'S "THE FIFTH DISCIPLINE"

QUESTION CONVENTIONAL WISDOM (CONT.)

- STICK TO WHAT YOU KNOW HOW TO DO
- ACCEPT WHAT YOU ARE TOLD, LITERALLY AND PRECISELY
- SMART FOLKS CARE ONLY ABOUT DOING GOOD WORK
- MAXIMIZE INTEGRATION (INTEGRATE ALL STOVEPIPES)

6. "OBVERSITY"

- FOCUS ON THE OBVERSE, THE NEGATIVE
- SOME EXAMPLES:
- -- Do Most Everything Ad Hoc
- -- No Learning from Mistakes
- -- Always Overpromise and Under-Deliver
- -- Reinvent the Wheel Whenever you Can
- -- Assume Requirements Are Correct and Set in Concrete
- -- Always Make Unrealistic Schedules
- -- Stop That Infernal Planning and Get to Work

4. BACK OF THE ENVELOPE (BOTE)

- BASIC IDEA: FIND THE SHORT FORM PENETRATING SOLUTION
- USE EXPERIENCE AND INTUITION TO DEFINE 1ST SOLUTION
- GREAT IDEAS IN PHYSICS – FIT ON "BOTE"
- -- MAXWELL'S EQUATIONS
- -- $E = MC^2$
- -- NEWTON'S GRAVITATION LAW
- -- INFORMATION THEORETIC ENTROPY
- -- MAN CAN FLY, BUT NOT LIKE A BUMBLEBEE

7. REMOVE CONSTRAINTS

- NO, IT CAN'T BE DONE (!)
- TYPICAL CONSTRAINTS

-- NOT ENOUGH FUNDING
-- NOT ENOUGH TIME
-- LACK OF TECHNICAL EXPERTISE
-- POOR DRIVING REQUIREMENTS
-- INFERIOR FACILITIES

5. EXPAND THE DIMENSIONS

- THE 3D SPREADSHEET
- COCOMO 1 → COCOMO 2, ETC.
- WELL-KNOWN MULTIFUNCTIONAL DEVICE
- WHERE TO PUT ELEVATORS?
- WHERE TO FLY OUR JETS?
- THE "GRAND UNIFIED THEORY"

8. THINKING WITH PICTURES

- - Arnheim (1969): Visual Perception Is a Cognitive Activity
- "A PICTURE IS WORTH 1000 WORDS"
- VARIOUS DIAGRAMMING TECHNIQUES
- PICTURE OF DoD ACQUISITION PROCESS/CYCLE
- CAN YOU DESCRIBE (IN WORDS):
- a. THE DODAF "PARADIGM"
- b. THE NATIONAL MISSILE DEFENSE SYSTEM
- c. THE MONA LISA

9. THE SYSTEMS APPROACH - 1

1. SYSTEMATIC & REPEATABLE PROCESS
2. CONFIRM INTEROPERABILITY
3. COST-EFFECTIVE SOLUTION FOR CLIENT
4. SPECIFIC ALTERNATIVES
5. ITERATE TO CONVERGE
6. SATISFIES ALL REQUIREMENTS
7. A ROBUST, SLOW-DIE SYSTEM
8. ASSURE SUSTAINABILITY
9. UTILIZE TECHNOLOGY, WITH DUE CONSIDERATION OF RISK
10. EMPLOY "SYSTEMS THINKING"

REDUCTIONISM

- "CLASSICAL" PROBLEM SOLVING AND THINKING
- ATTRIBUTED TO DESCARTES
- BREAK PROBLEM INTO KEY PIECES
- GENERALIZATION OF FUNCTIONAL DECOMPOSITION
- HOW TO INTEGRATE "SMALLER" SOLUTIONS?
- EXAMPLE: NASA EARTH OBSERVATION SATELLITES

THE SYSTEMS APPROACH - 2

- SOME EXAMPLES:
- 1. BOEHM, RESPONSE TIME TRADES
- 2. EISNER, CLOCK TIME PROBLEM
- 3. EISNER, ARCHITECTING ALTERNATIVES
- 4. LOOKING AT A COMPLETELY DIFFERENT SYSTEMS ACQUISITION PROCESS, FOR CERTAIN CLASSES OF SYSTEMS → 2500% GAIN?!

LATERAL THINKING

- DEVELOPED BY EDWARD deBONO (*)
- "SIDEWAYS" THINKING AND SOLUTIONS
- GENERATE ALTERNATIVES
- DIG DEEPER OR FIND OTHER "HOLES" TO EXPLORE
- IN RADAR BUSINESS – GO TO "CHIRP RADAR" OR GO TO SONAR
- IN RR BUSINESS – GO TO HIGH SPEED RAIL OR SHIP-BUILDING
- IN MOTORCYCLE BUSINESS – GO TO SCOOTER BUSINESS OR ELECTRIC BICYCLES
- (*) E. de Bono, "The Use of Lateral Thinking", 1971

SYSTEMS THINKING

- KEY WORDS – HOLISTIC, INTEGRATED, INCLUSIVE, NEAR-OPTIMAL, LEVERAGE, SUBJECT TO LARGE-SCALE TRADEOFFS
- SEEKING COST-EFFECTIVE SOLUTIONS FOR CUSTOMER(S) & STAKEHOLDERS
- CHALLENGING SUBSYSTEM OPTIMA
- INCLUDES "THE SYSTEMS APPROACH" ELEMENTS
- SENGE'S "FIFTH DISCIPLINE"
- MANY PROPONENTS IN U.K.

SIX THINKING HATS (STH)

- WHITE: FACTS, FIGURES
- RED: EMOTIONS, FEELINGS
- BLACK: CAUTIOUS, CAREFUL
- YELLOW: SPECULATIVE
- GREEN: CREATIVE THINKING
- BLUE: CONTROL AND SUMMARIES

- Developed by Edward deBono, STH, 1985

DESIGN THINKING

- "CHANGE BY DESIGN", TIM BROWN (2009)
- IDEO COMPANY
- INNOVATION: INSPIRATION, IDEATION, IMPLEMENTATION
- BALANCE: DESIRABILITY, VIABILITY, FEASIBILITY
- "INTEGRATIVE" THINKING
- VISUAL THINKING
- BUILD MODELS
- TEAMS

FUNCTIONAL DECOMPOSITION

- A CRITICAL ELEMENT OF SYSTEMS ENGINEERING
- KEY STEP IN "ARCHITECTING"
- ROLE IN DEVELOPING ALTERNATIVES
- HOW MANY LEVELS FOR DECOMPOSITION?
- TYPICAL ANSWER → THREE (!?)
- AN IBM STORY, IMPLICATIONS

DISRUPTIVE THINKING

- "DISRUPT", LUKE WILLIAMS (2011)
- START WITH "DISRUPTIVE" HYPOTHESIS
- POWERFUL MARKET DISRUPTION
- EXAMPLES: SOCKS IN SETS OF 3; PLUMBING ON BUILDING OUTSIDE; REFRIGERATOR; AUTOMOBILE; COPIER
- INVOLVE END USER TO TEST AND VERIFY
- USE PROTOTYPING
- BASED UPON DISRUPTIVE TECHNOLOGY

THE MORPHOLOGICAL BOX

- ATTRIBUTED TO F. ZWICKY (*)
- SYNTHESIS, INVENTION & DISCOVERY
- CITE KEY PARAMETERS/VARIABLES
- EXAMPLE: TYPE of ENGINE VS. TYPE of FUEL
- PLOT TO DEVELOP BOXES OR CELL
- INVESTIGATE ALL CELLS

- F. ZWICKY, "Discovery, Invention, Research", 1969; IN HE Book

GROUPTHINK

- PHRASE COINED BY PROF. I. JANIS
- POOR GROUP THINKING AND DECISION MAKING
- "BAY OF PIGS"
- ABILENE PARADOX
- WHAT CAN GO WRONG?
  - – BAD/INCOMPLETE INFORMATION
  - – DOMINANT ADVOCATE WITH WRONG ANSWER
  - – DON'T HEAR FROM ALL
  - – NO ALTERNATIVES OR CONSIDERATION OF RISK
  - – POOR FACILITATION SKILLS/PROCESS → OTHER?

ADVOCACY vs INQUIRY

- <u>ADVOCACY</u>
- --HARVARD BUS. REVIEW CLAIMS IT IS AMONG THE LEAST PRODUCTIVE APPROACHES
- --QUITE PREVALENT
- <u>INQUIRY</u>
- -- ENCOURAGES CONSTRUCTIVE CONFLICT
- -- ALL POINTS OF VIEW HEARD
- --KNOW WHEN AND HOW TO CLOSE DELIBERATIONS

OTHER NOTEWORTHY APPROACHES

- DEVELOP EXPERT FACILITATORS FOR TEAMS
- CHURCHMAN'S STRATEGIC ASSUMPTION TESTING
- THE DELPHI PROCESS & SPINOFFS
- SELF-DIRECTED WORK TEAMS
- SYNECTICS – METAPHORS, ANALOGIES, "FAR-OUT" IDEAS
- 2-3 PERSON (vs TEAM) COLLABORATION
- VARIOUS FORMS OF TEAMS AND TEAMBUILDING
- SPINOFFS OF "DESIGN" AND "DISRUPTIVE" THINKING

ENTREPRENEURIAL - 3

- SELF-DRIVING CARS
- CAR BATTERIES
- SOLAR POWER
- UBER – USE OF EXISTING RESOURCES
- ISO EXCELLENCE
- PETER DRUCKER

ENTREPRENEURIAL - 1

- AUGUSTINE
- BEZOS/AMAZON
- NETFLIX
- FACEBOOK
- HALOID/XEROX

GOOGLE
STEVE JOBS
IACOCCA
GENEEN
EASTMAN KODAK

"GENERIC" ENTREPRENEURIAL - 1

- MASSIVE MARKET DEMAND
- TECHNOLOGY BREAKTHROUGH
- MULTI-FUNCTIONAL
- ONE PERSON'S JUNK IS ANOTHERS' TREASURE
- SOFTWARE RE-USE

ENTREPRENEURIAL - 2

- HAMMER & CHAMPY (BPR)
- IBM – WATSONS, GERSTNER
- MICROSOFT – SOFTWARE IS STILL KING
- SENGE – THE LEARNING ORGANIZATION...
- GOOGLE
- IDEO – TIM BROWN
- DISRUPTIVE TECHNOLOGY/THINKING

"GENERIC" ENTREPRENEURIAL - 2

- 90% SOLUTION AT ONE-HALF THE PRICE
- INCREDIBLY HIGH LEVERAGE (NEW PROCESS)
- NEW DESIGN CONFIGURATION/MATERIALS
- INTERNET – ALL ATTRIBUTES AND FEATURES/CAPABILITIES (E.G., "FIND ME"); THE GAME CHANGER