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FDNA Approach to Assessing Mission-Risk in Governing Research and Development

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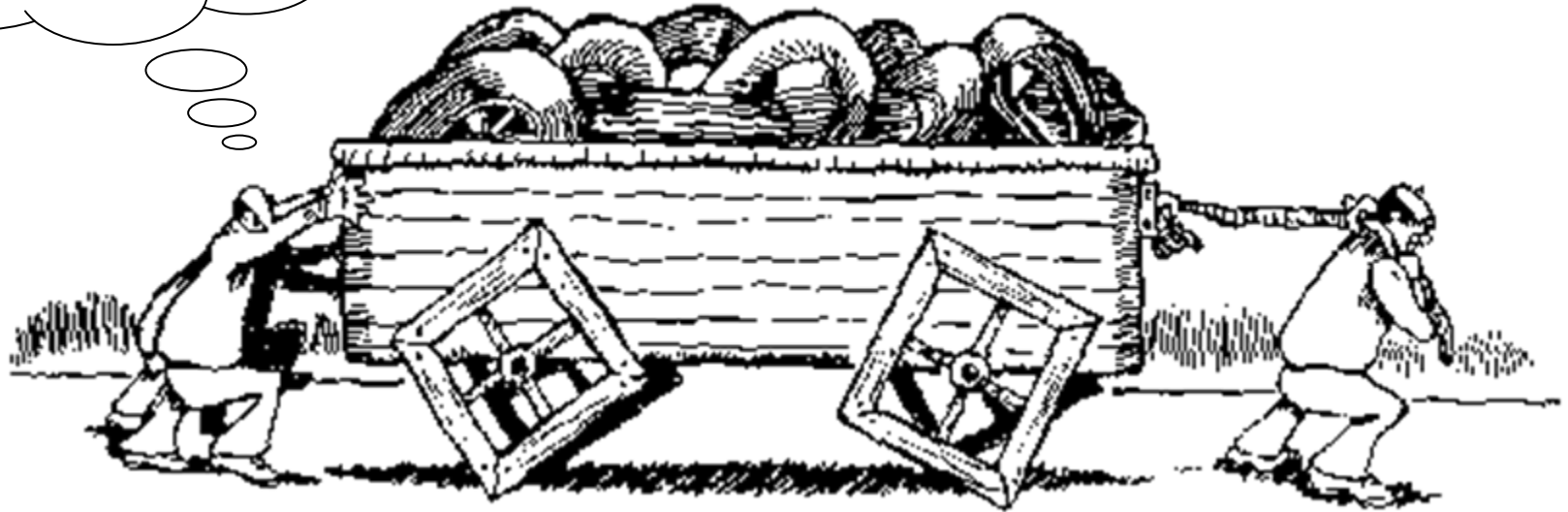


Department of Engineering Management & Systems Engineering



Setting the Stage

*...and we are
doing this
because...?*

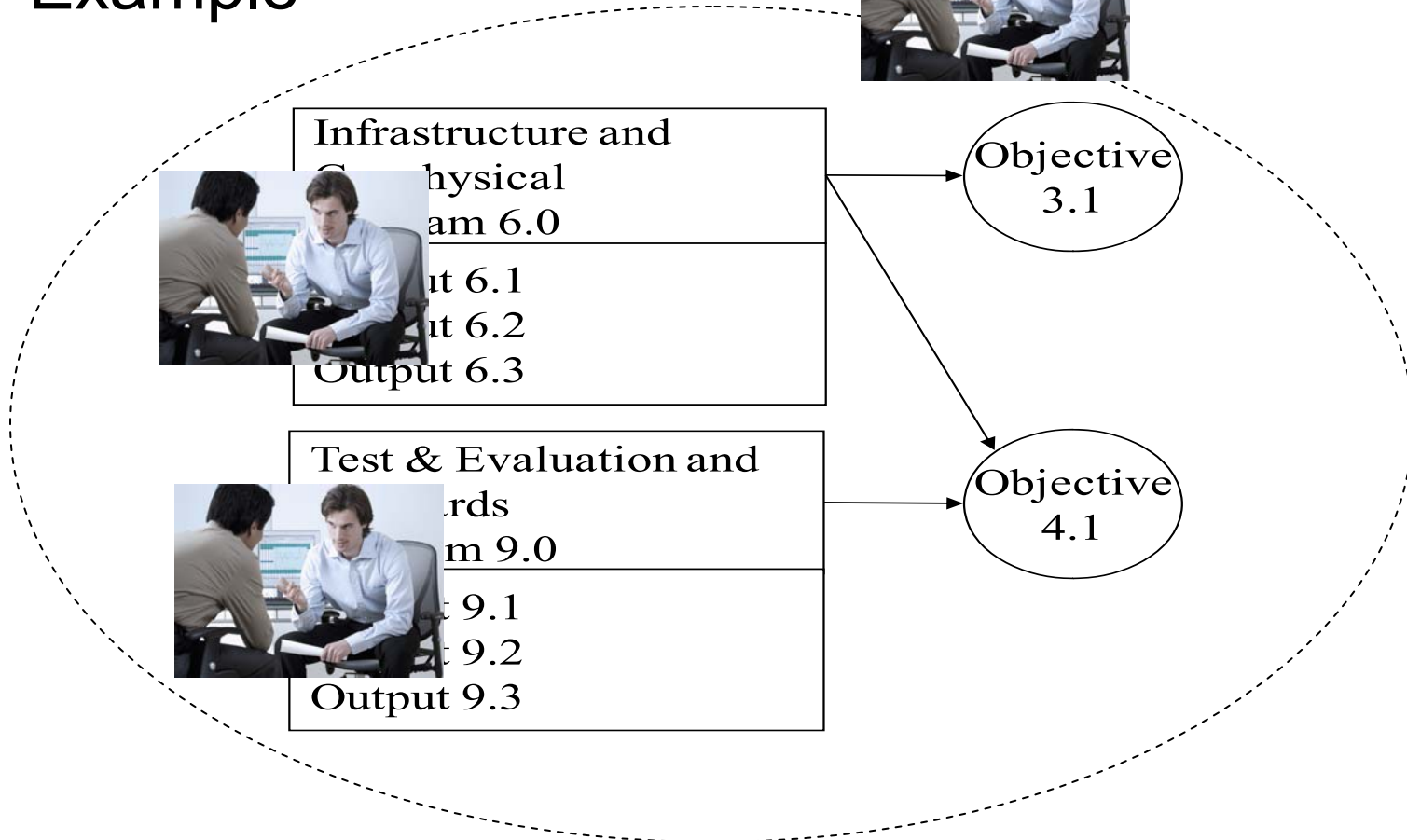


Setting the Stage



Setting the Stage

Example

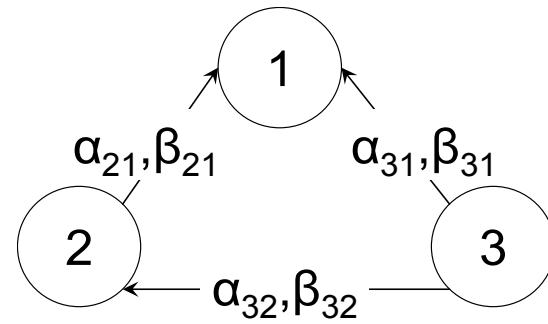


R&D

- R&D outputs- characteristically defines an R&D, i.e. knowledge and applications
- R&D programs - a unit that properties such as objective, cost, schedule, technical performance, programmatics, and others similar to any other project; also having properties of input as well as resulting (or output) knowledge and applications.
- R&D portfolio - a collection of time-phased R&D programs undertaken to attain an organization's higher-level objective or mission

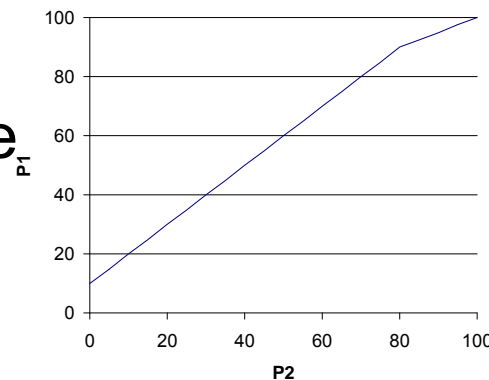
FDNA

- Uses network topology to model dependencies
- Not predicated on control over any subset of the nodes
- Describes association among nodes (e.g. heap, torsor)
- Calculates operability, the primary performance measure or system state



Generalized FDNA Graph

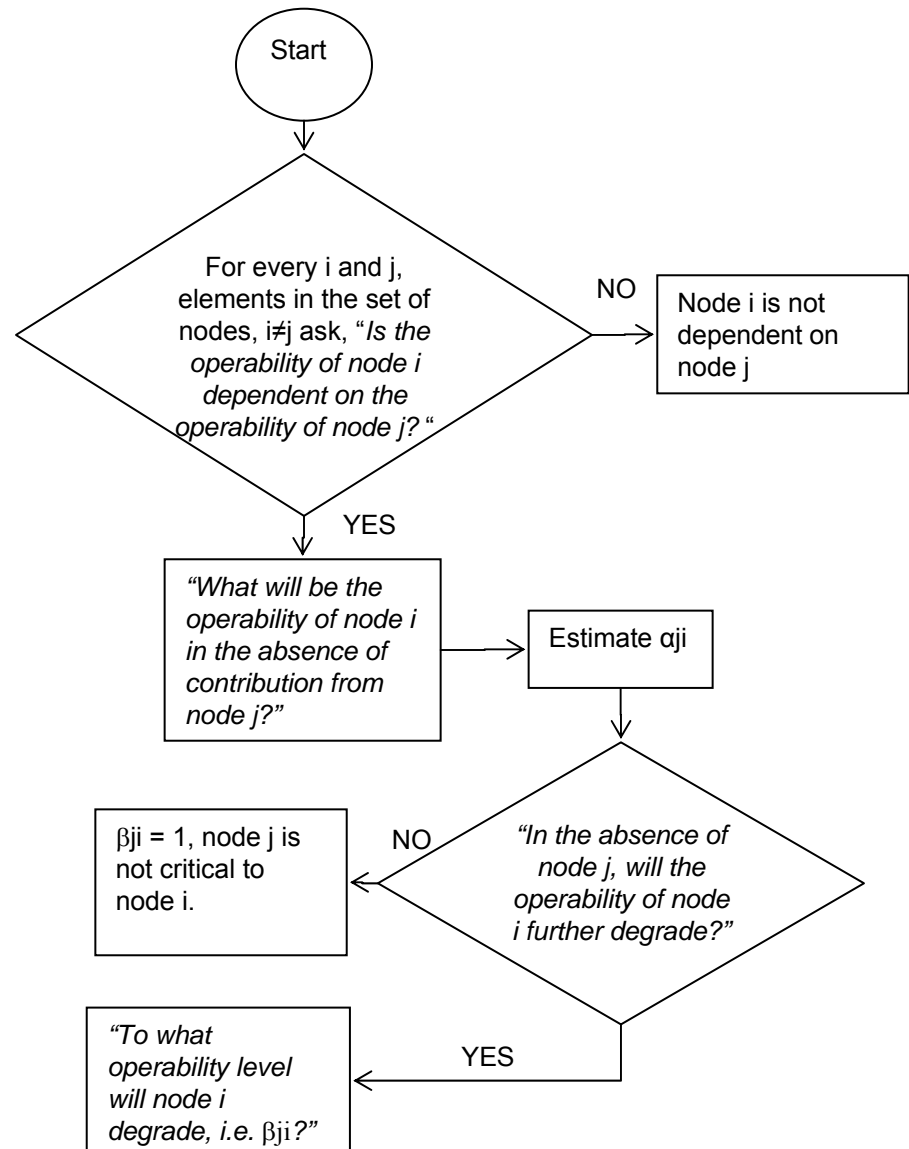
$$P_1 = \text{Min} \left(\begin{array}{l} \frac{\alpha_{21}P_2}{2} + \frac{\alpha_{31}P_3}{2} \\ + 100(1 - (\frac{\alpha_{21} + \alpha_{31}}{2})), \\ P_2 + \beta_{21}, \\ P_3 + \beta_{31} \end{array} \right)$$



$$P_2 = \text{Min} \left(\begin{array}{l} \alpha_{32}P_3 + 100(1 - \alpha_{32}), \\ P_3 + \beta_{32}, \end{array} \right)$$

FDNA

- Two types of dependencies:
 - strength
 - criticality



Modified FDNA

Proposition 1. A portfolio of R&D programs and its missions can be modeled as a network where the nodes represent the output knowledge and applications while the directed arrows represent the receiver-feeder relationship.

Proposition 2. The dependencies among R&D output knowledge and application as well as portfolio missions can be described by two properties: strength and criticality.

Modified FDNA (cont'd)

Proposition 3. The operability of an R&D output can be expressed as a von Neumann/Morgenstern (vNM) utility/value measure expressed as “utils” that can be derived from program properties such as cost, schedule, technical performance, programmatics, and others similar to a typical project, in addition to inputs coming from feeder nodes. That is,

$$P_i = f(\text{program properties}, P_j)$$

for all feeder node j 's where P_j are the operability of these feeder nodes; P_i is the operability level of node i .

Modified FDNA (cont'd)

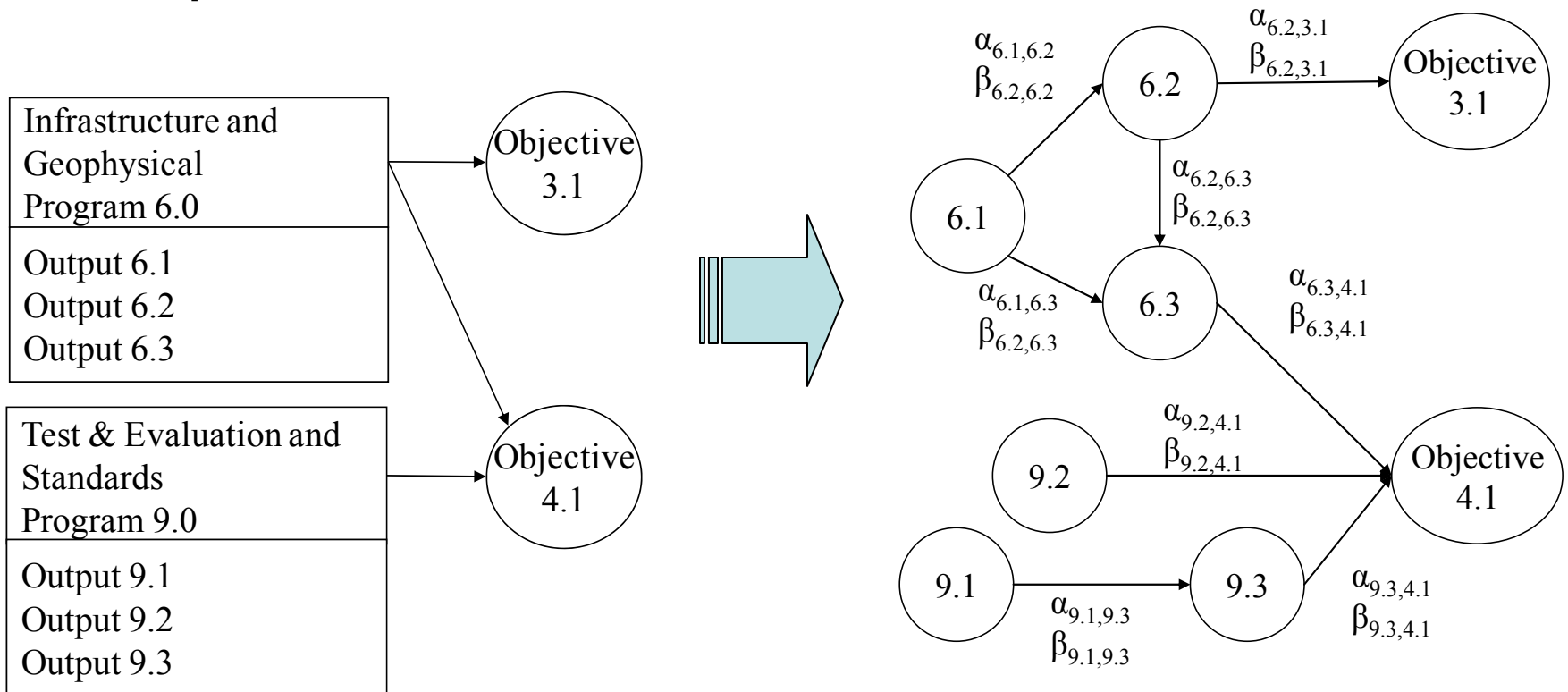
Proposition 4. The attainment of an R&D portfolio's missions can be expressed as a von Neumann/Morgenstern (vNM) utility/value measure expressed as “utils” that can be derived from the operability levels of the R&D output knowledge and application comprising the portfolio. That is,

$$P_x = f(P_1, P_2, \dots, P_i)$$

where P_x is the operability level of node x representing a portfolio's mission and P_i 's are nodes representing R&D output knowledge and applications.

Modified FDNA (cont'd)

Example



For EM's and SE's



For EM's and SE's

- Allows abstraction of R&D portfolio in terms of outputs, instead of programs,...
- Allows modeling of delayed, failed, new, and unintentional R&D outputs to be mapped with portfolio missions...

...towards better assessment and management of
mission-risk

Future Works

- Modifying notion of strength and criticality of dependency
- Examination of FDNA calculus
- Scalability
- Towards optimization (?)

Q&A



Primary references

- Garvey, Paul. and C. Ariel Pinto, "An Introduction To Functional Dependency Network Analysis: A New Formalism For Measuring And Managing Dependency Risks In Engineering Enterprise Systems", Proceedings of the Second International Symposium on Engineering Systems, Massachusetts Institute of Technology, Boston, MA, (June 2009).
- Hester, Patrick., Charles B. Keating, Kevin M. Adams, Luna M. Magpili, Rani Kady, and Behnido Y. Calida Research in R&D Governance for DHS Science and Technology: Need, Relevance, & Opportunity (NCSOSE-TR-2009-03). Norfolk, Virginia: Old Dominion University, National Centers for System of Systems Engineering, (2009).
- Keating, Charles B., Kevin M. Adams, Luna M. Magpili, Patrick Hester, Rani Kady, and Behnido Y. Calida, A Research Program in R&D Governance for DHS Science and Technology: Need, Relevance, & Opportunity (NCSOSE-TR-073008). Norfolk, Virginia: Old Dominion University, National Centers for System of Systems Engineering (2008).