



Innovation Appraisal Group * Gideon Samid, PhD

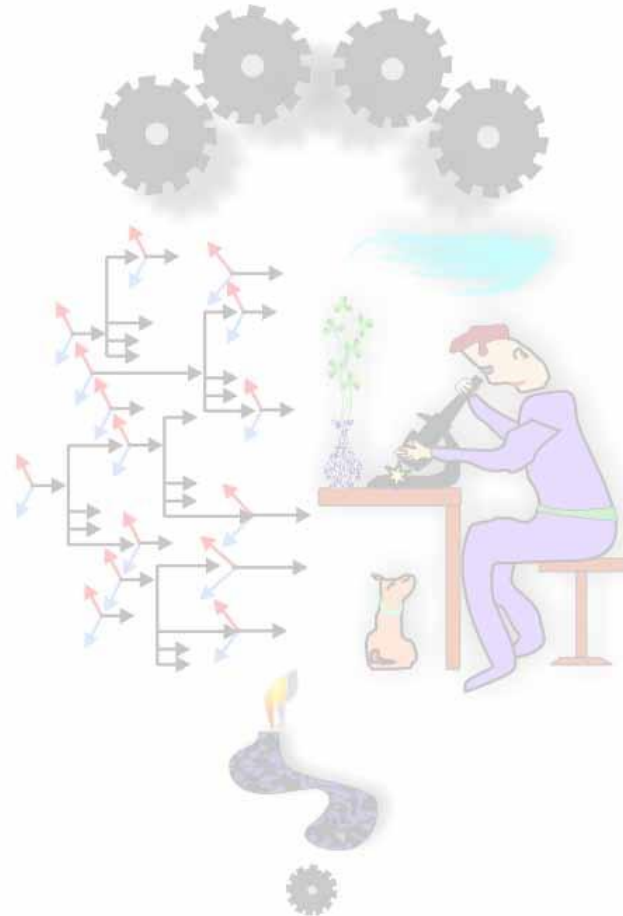
Chemical Engineering ***Design***

Innovative Chemical Engineering

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Design v. Research

- In R&D errors, missteps, retreats are normal and expected. Not so in Design.
- In R&D the question is '*what will work?*' In design the question is '*what will work efficiently*'. A poor-design will do the same job – but less efficiently, risking feasibility.
- Anybody can do research, design may require a license (PE v. PhD).



Design Embarrassment

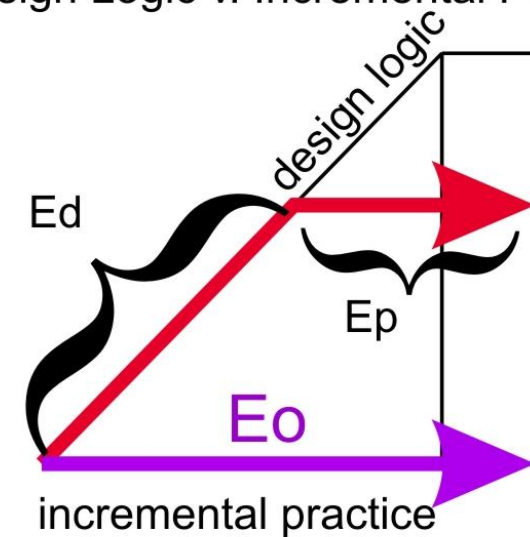
- The earlier the mistake, the greater its cost – so pay more attention to the higher (abstract) levels.
- els.



Design Logic v. Incremental Practice

- Design Logic offers shortcuts vs. incremental practice, with the risk of major missteps.
- Novice – tilt towards incremental practice, Expert – tilt towards design logic.

Design Logic v. Incremental Practice



$$E_d + E_p < E_o$$

Options

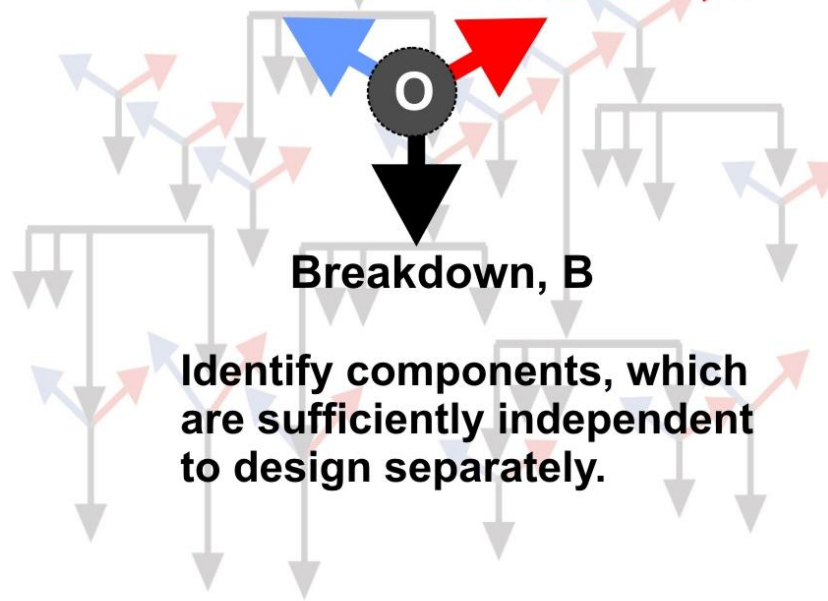
Design Challenge (DC)

Redefine your challenge
with greater abstraction

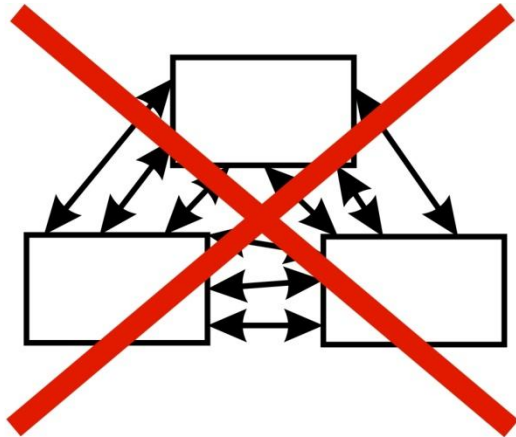
Abstraction, A

Consider matching design
cases for unified consideration

Extension, X



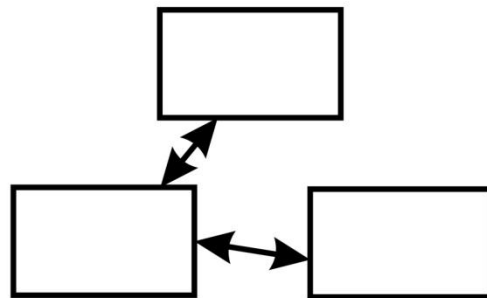
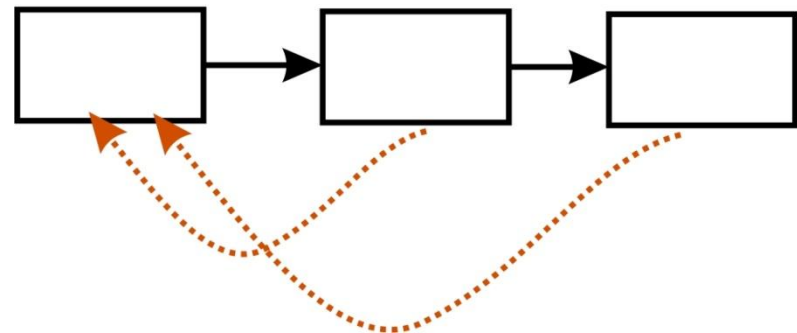
Breakdown



Ideal (waterfall) Design Components

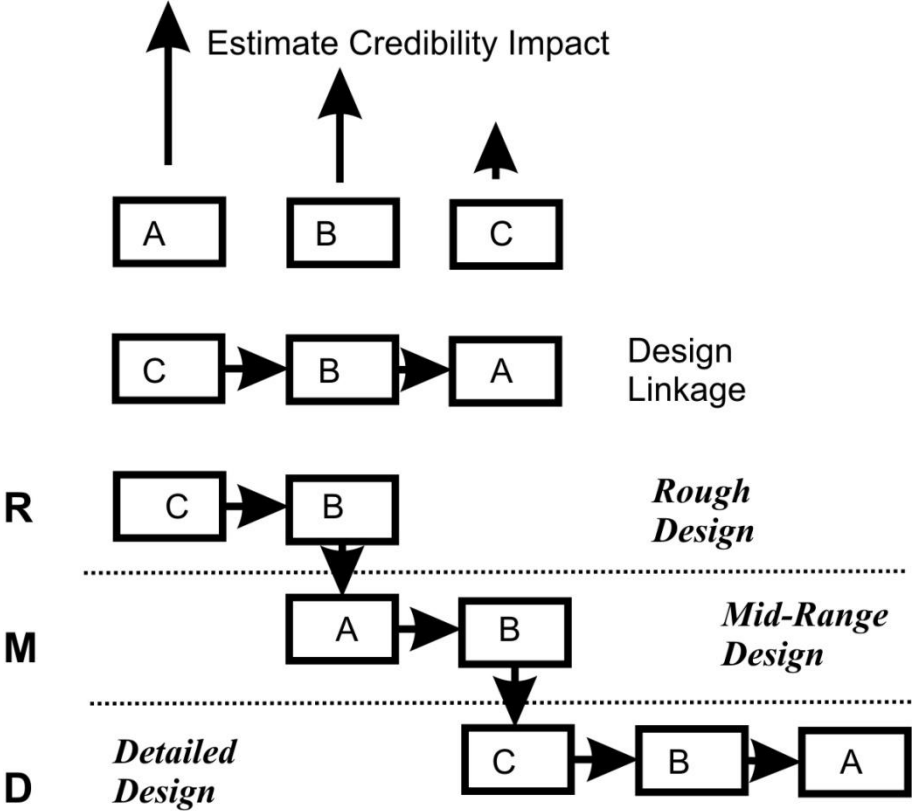


Real (feedback) Design Components



Design Components should be as stand-alone as possible

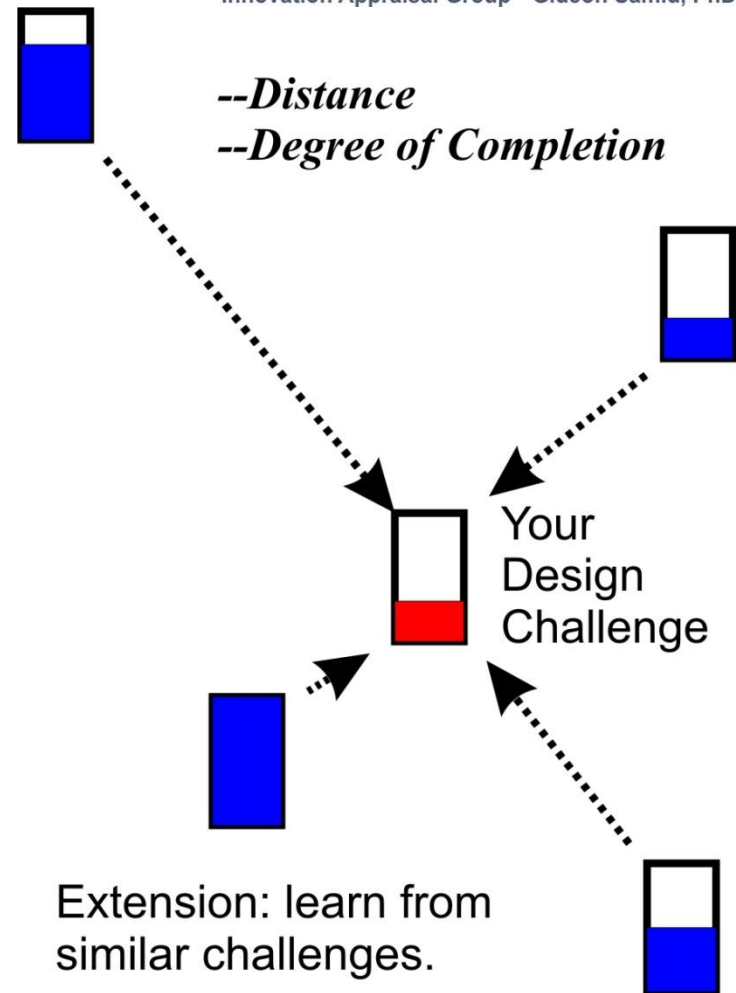
Design Grades



When estimate credibility impact is in conflict with design linkage use rough to detailed design cycles

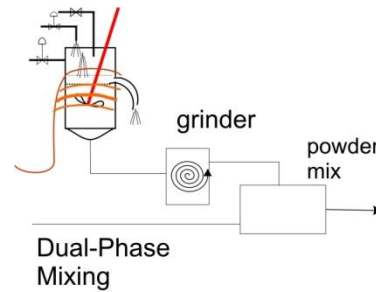
Extension

- Explore in-house lateral design projects to be combined into a comprehensive project – better design talent, more budget, shared-insight.
- Identify similar design challenges and their solutions – in-house, IP-protected databases, public domain – Don't re-invent the wheel, examine (not just imagine) results.
- E.g.: copolymerization of styrene with varying amounts of divinylbenzene (resin manuf.), and styrene with butadiene – insuring desired sequence.

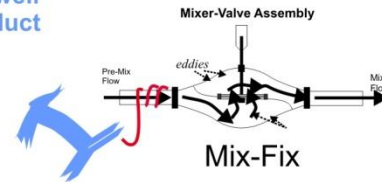


Abstraction

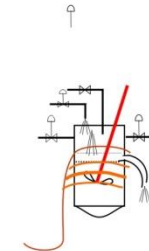
- Redefine the DC (design challenge) with greater abstraction



Achieve a well mixed product

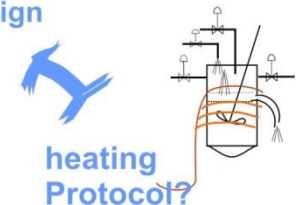


Build a mixing apparatus



Reactor Design

Seven ingredients mixing challenge had a conflict: high temp needed for mixing viscosity, triggered side reaction between two ingredients



heating Protocol?

Abstraction

Broadens the solution range, engages more ideas and sources.

Managing Chemical Engineering Designers



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- Full Documentation
- Budget for designer and evaluator
- Perform Sensitivity Analysis
- The Next Alternative Challenge
- Cost Modeling
- Performance Guarantees
- Responsibility Distribution
- Subcontracting Visibility, Reassignment



Design Documentation



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- Terms, Assumptions, Options, Consideration, Decision Argument (signed by designer, approved by supervisor).
- Layman readability
- Identify shortcuts, arbitrary selections.

Designer & Evaluator



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- Designers work harder and more seriously when subject to peer review and evaluation.
- In case of budget constraints: random choice of design feature to evaluate.
- Evaluation report in writing, under signature.
- Evaluation Guide: feasibility, optimality, identify the weakest aspect, need more designing attention?

Sensitivity Analysis



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- Evaluate design changes if process parameters are slightly changed.
- Typical changes: reaction temperature, viscosity, flow rates, pressures, vacuum, density, production capacity; incidental limitations: size, height, regulatory constraints.
- Evaluate per up and down changes, unitary changes, and combo
- Which change(s) will have a considerable impact on design product.

Next Alternative



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- Challenge: if the specified design were unacceptable for some external reason, what would be an alternative to it?
- How much better (and in what way) is the nominal design compared to the identified alternative?
- Repeat for any desired design feature.

Cost Modeling



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- Don't buy a 'cost figure' buy a cost model: allowing you to change input parameters and read new cost figures.
- A crucial negotiation tool towards the construction contractor.
- Insist on total visibility of the model: Excel sheets for simple cases, non-compiled programming language for complicated ones. Recommendation: JavaScript/PhP

Performance Guarantees

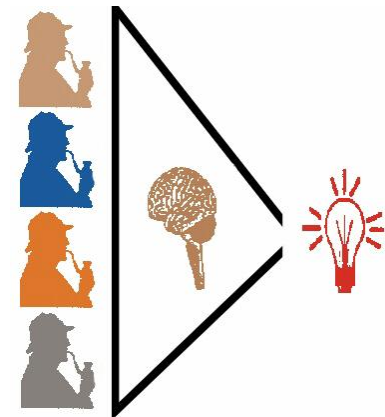


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- Clear design goals may be guaranteed. e.g.: pumping capacity, heat-exchange capacity. If constructed to specification, a non-performing assembly is the designer's fault.
- Check for designer insurance to substantiate the guarantee
- Optimality, and subjective aspects are not conducive to guarantee clauses

Responsibility Distribution

- Assign different design aspects to different examiners: functionality, operability, cost-effectiveness, maintainability, safety, security, reuse.
- Obtain design-wide opinion using BiPSA. E.g.: “*This Design Document has no major deficiencies*” – comfortable/uncomfortable with this statement (integrate binary results). These on-the-record opinions get people’s attention. Refusers are disengaged.



Subcontracting Visibility, Reassignment



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- Insist on visibility of subcontracting to insure feasibility of work.
- Protect against main contractor being compensated for schedule overrun beyond compensation to the owner.
- To minimize disturbance in case of fault of main contractor, attempt to re-assign contract to new main contractor.

Seminar Offerings



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- Engineering is Cost Engineering
- Chemical Engineering for Innovative Chemistry
- Innovation Acceleration Methodologies
- The Universal Theory of Innovation
- Innovation Management
- BiPSA: Management by Inclusion
- Nurturing the Culture of Innovation

Seminars range from a single evening overview, a dedicated Saturday; six, ten, and thirty hours on a weekly or bi-weekly basis, and per-case arrangements.

Seminars are offered (1) online, (2) at Case Western Reserve University, (3) on the road, (4) on customer's location.

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