System Engineered Research and Development Management

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How can we get more from our labs with less money?

- The Problem: Uncoordinated and duplicate work
- The Result: Unconvincing justification for work and money expended
- The Solution: System Engineered R&D Management
  - Establish a solid trace from vision, goals and objectives down through the layers to the research result.
  - Standardize reporting across all programs with metrics
  - Increase project transparency to stakeholders

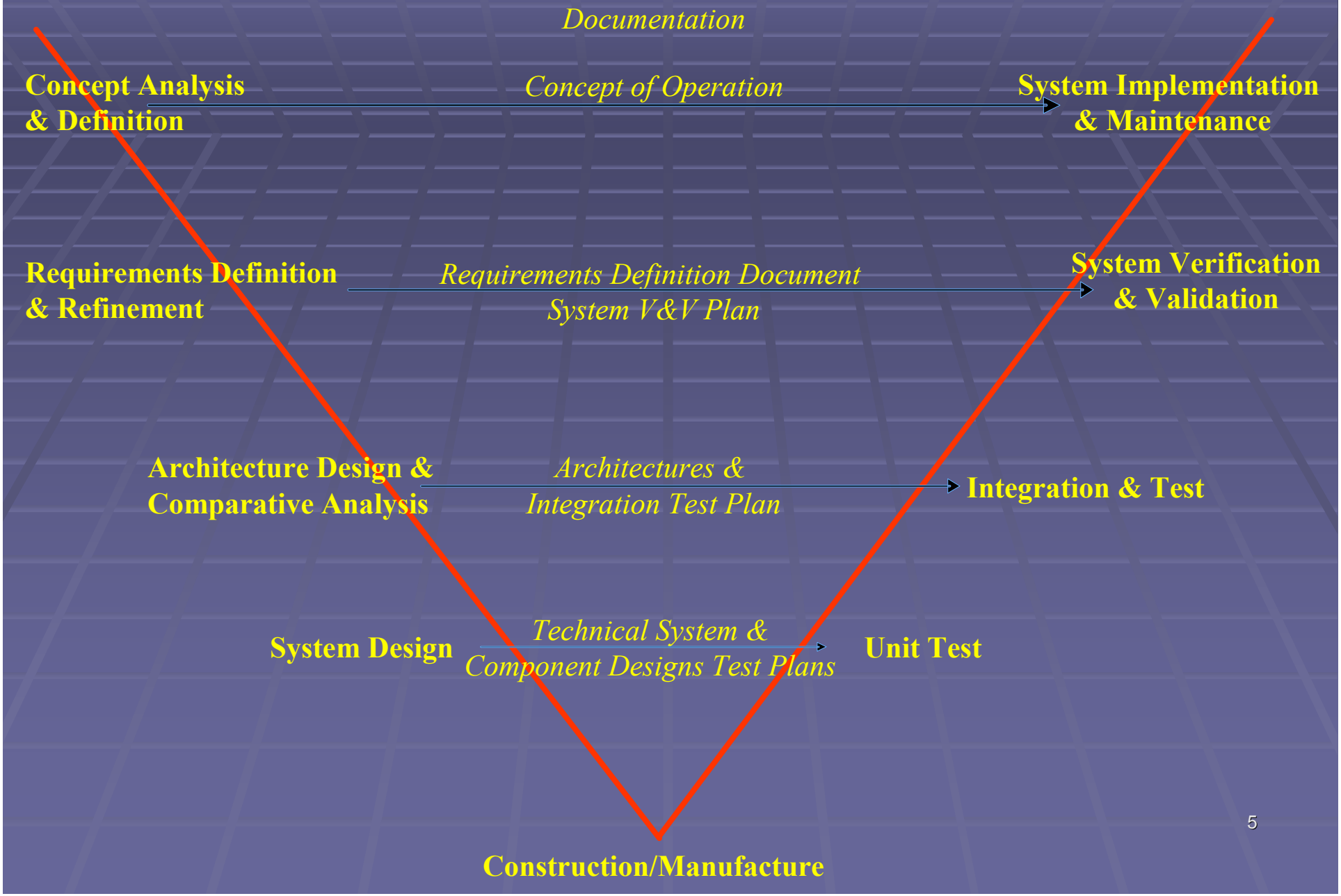
Background

- Hired to look at a Federal Directorate's engineering and business practices
- Reviewed directorate's projects and their relationship with labs
- Study compared existing practices against the FAA's ICMM™
- Reactions weren't as positive as we would have hoped among the program managers
  - We don't build, we discover!
  - System Engineering is too rigid, it would stifle creativity!
  - There are too many interdependencies, it would be too hard to trace!
  - What would happen to programs that didn't fit in? this could mean death to them!
  - We're too busy to bother with all that!

Not so fast!

We don't build, we discover!	**Elimination of duplication frees time to discover**
System Engineering is too rigid, it would stifle creativity!	**Creativity is stifled by mind numbing administrative exercises, not a systematic approach to problems**
There are too many interdependencies, it would be too hard to trace!	**Tracing, even if incomplete, exposes potential synergies and facilitates quicker advances**
What would happen to programs that didn't fit in? this could mean death to them!	**Is this such a bad thing?**
We're too busy to bother with all that!	**Elimination of duplication frees time to manage**

The Traditional System Engineering "Vee"



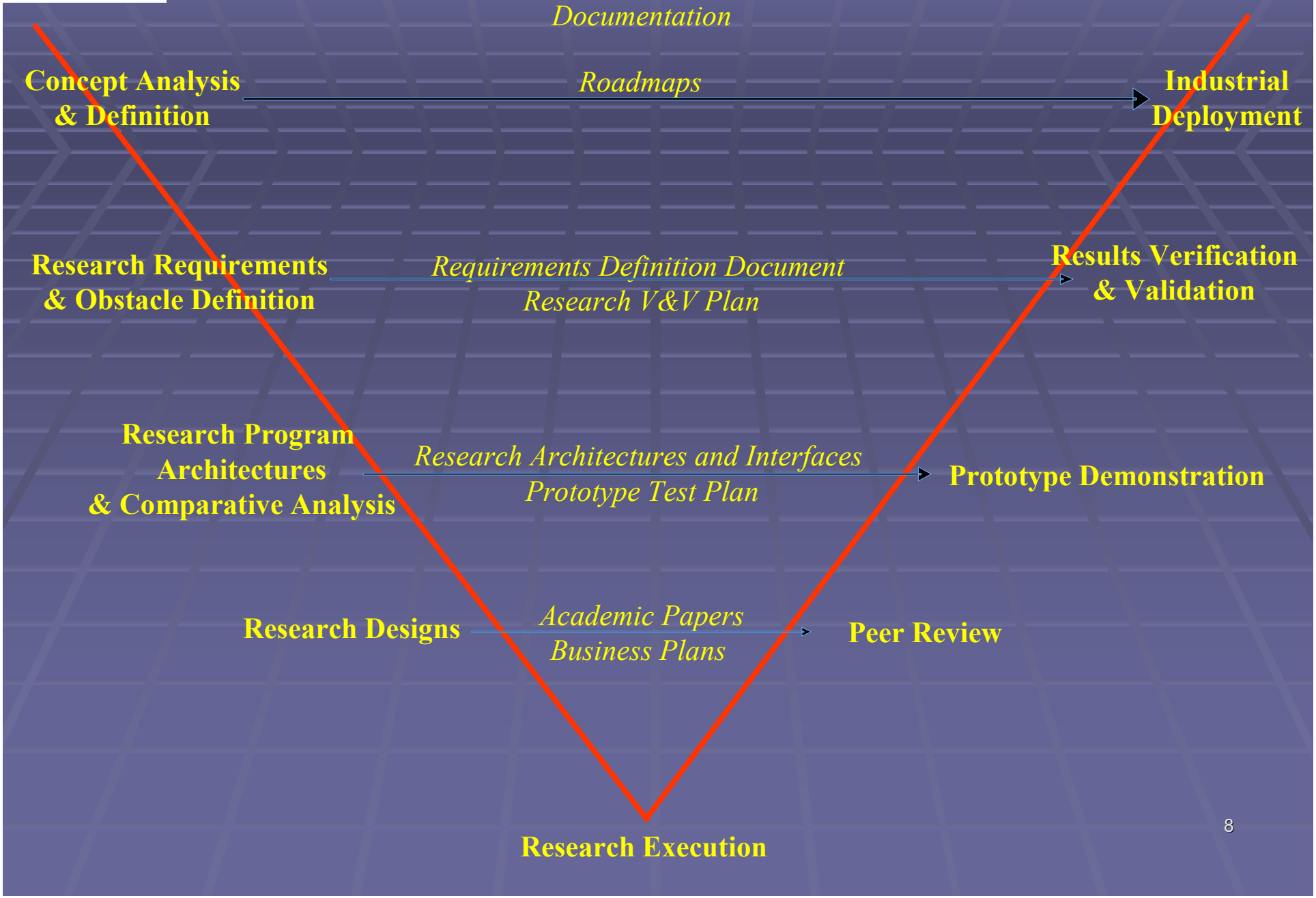
The Need to Tailor the "Vee" for R&D

- Needs and Requirements
  - Activities need to be done but the level of detail may not be adequate in an R&D effort
  - CMMI® doesn't envision the parts makers going off in their own directions looking for a better mousetrap
- Architectures
  - R&D Managers tend to shy away from them as a planning tool because of the difficulty in defining where the interdependencies are
- Designs
  - Usually associated with specifications, much too detailed for conducting research
- Construction/Manufacture
  - Activities really don't align well with conducting research

The Need to Tailor the "Vee" for R&D

- Integration, Test and Evaluation
  - Often research is reported in papers, etc. Doesn't fit well with traditional testing
  - Peer Reviews, Body of Knowledge Reviews fit here
- Verification and Validation
  - Not an exact fit, but if the homework was done at concept and requirements definition, then there is a body of requirements against which research can be evaluated, and a body of growing knowledge to review for adequacy in fulfilling stakeholder needs
- Deployment
  - Federal R&D is usually deployed by industry partners. If the concept plan was laid out with their participation, and if the research traces adequately to that concept, the Industry's ability to grasp the results and run is increased.
  - The likelihood of implementation is greatly increased.

The R&D "Vee"


Documentation
Concept Analysis & Definition
Roadmaps
Industrial Deployment
Research Requirements & Obstacle Definition
Requirements Definition Document
Research V&V Plan
Results Verification & Validation
Research Program Architectures & Comparative Analysis
Research Architectures and Interfaces
Prototype Test Plan
Prototype Demonstration
Research Designs
Academic Papers
Business Plans
Peer Review
Research Execution

Expect these Results!

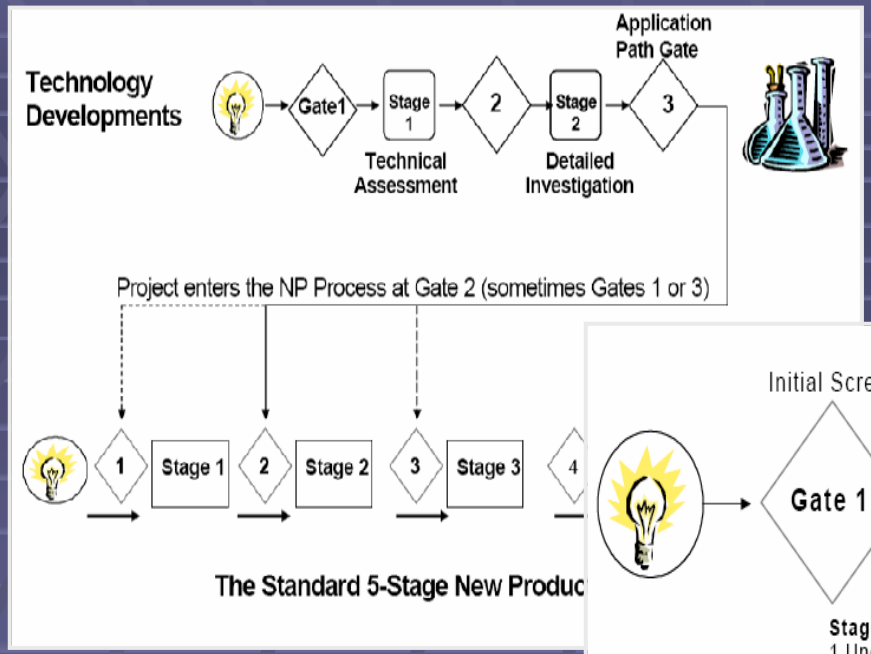
- Generate transparent traceability from user-specified needs to delivered research
- Demonstrate how conducted research is contributing to the overall solution
- Involve the industrial partners in tailoring research to answering their general needs in overcoming high-risk obstacles to new product delivery, and
- Orchestrate deployment of research into practical application

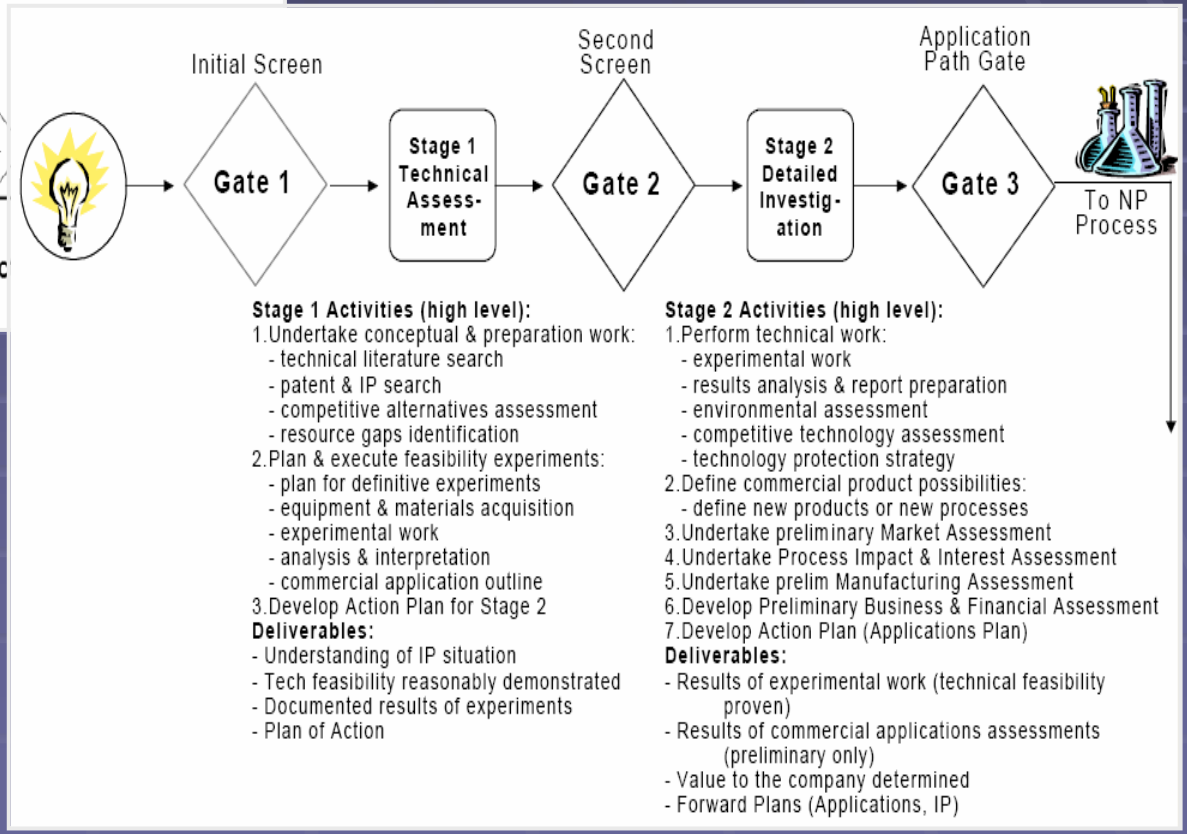
R&D Program Reviews

- StageGate® Management being effectively used at one lab
  - Large body of literature, much written by Dr. Robert G. Cooper (www.prod-dev.com)
  - Conceptual and operational roadmap for moving new-products from idea to launch
  - Widely used in industry
  - New Product Development has 6 stages & 5 gates
- Recognizing the need for modification to fit Technical Development, Cooper et. Al. have modified this with the StageGate-TD® Model.

Stages	Gates
Discovery	Idea Screen
1-Scoping	Second Screen
2-Build Business Case	Go to Development
3-Development	Go to Testing
4-Testing& Validation	Go to Launch
5-Launch	

StageGate-TD®





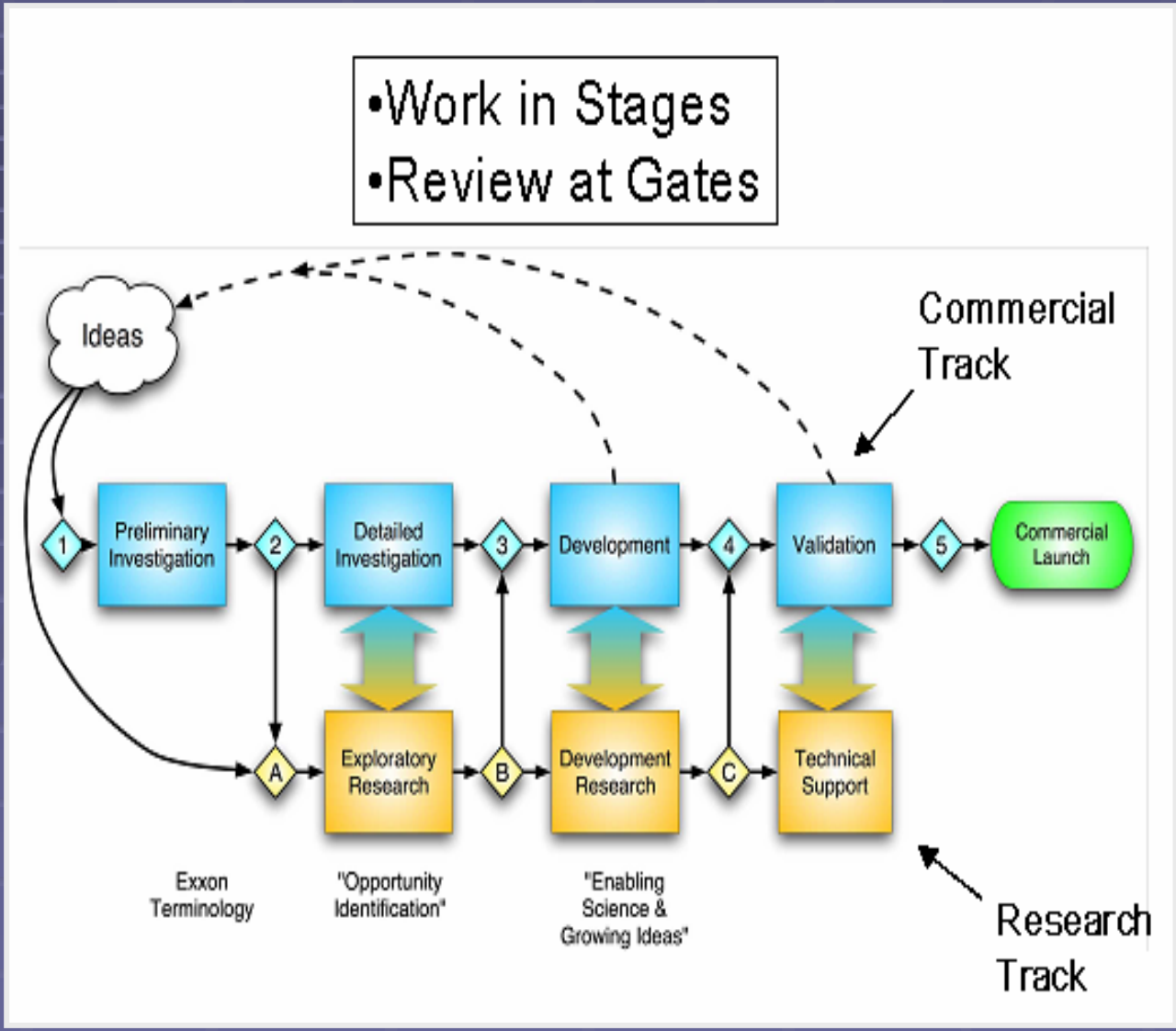
Stage 1 Activities (high level):
1. Undertake conceptual & preparation work:
   - technical literature search
   - patent & IP search
   - competitive alternatives assessment
   - resource gaps identification
2. Plan & execute feasibility experiments:
   - plan for definitive experiments
   - equipment & materials acquisition
   - experimental work
   - analysis & interpretation
   - commercial application outline
3. Develop Action Plan for Stage 2

Deliverables:
- Understanding of IP situation
- Tech feasibility reasonably demonstrated
- Documented results of experiments
- Plan of Action

Stage 2 Activities (high level):
1. Perform technical work:
   - experimental work
   - results analysis & report preparation
   - environmental assessment
   - competitive technology assessment
   - technology protection strategy
2. Define commercial product possibilities:
   - define new products or new processes
3. Undertake preliminary Market Assessment
4. Undertake Process Impact & Interest Assessment
5. Undertake prelim Manufacturing Assessment
6. Develop Preliminary Business & Financial Assessment
7. Develop Action Plan (Applications Plan)

Deliverables:
- Results of experimental work (technical feasibility proven)
- Results of commercial applications assessments (preliminary only)
- Value to the company determined
- Forward Plans (Applications, IP)

A Federal Lab's StageGate Process



The R&D Research Portfolio

- Dr. Cooper suggests that "a stage-gate process focuses on *one project at a time*; by contrast, portfolio management considers *all projects together*.
- R&D needs to be evaluated in the context from which it is sponsored
  - Does it help answer the strategic question?
  - Does it hold any greater potential for overcoming obstacles?
- Senior Directorate Managers need to get involved at this to ensure that ongoing R&D
  - Maximizes the ability of industry to overcome strategic barriers
  - Is balanced and is effectively using available resources
  - Is of a mixture aligned with current policies and goals

In Summary

Implementation of this approach will yield immediate pay-offs in:

- Reduced redundancy between managers through incorporation of standard best practices
- Increase accountability of R&D program managers and researchers towards meeting Federally defined research objectives
- Greater understanding of the impacts of one program's performance vis-à-vis the overall R&D portfolio mix, and
- Increased transparency of program progress to all stakeholders

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