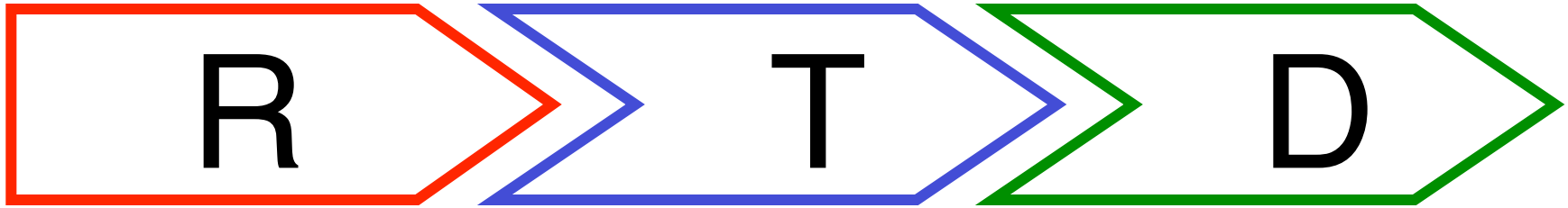# Introduction

Teaching materials to accompany:

Product Design and Development
Chapter 1

Karl T. Ulrich and Steven D. Eppinger
5th Edition, Irwin McGraw-Hill, 2012.

Research and Development

R → **T** → **D**

Basic Research

- Discovery process
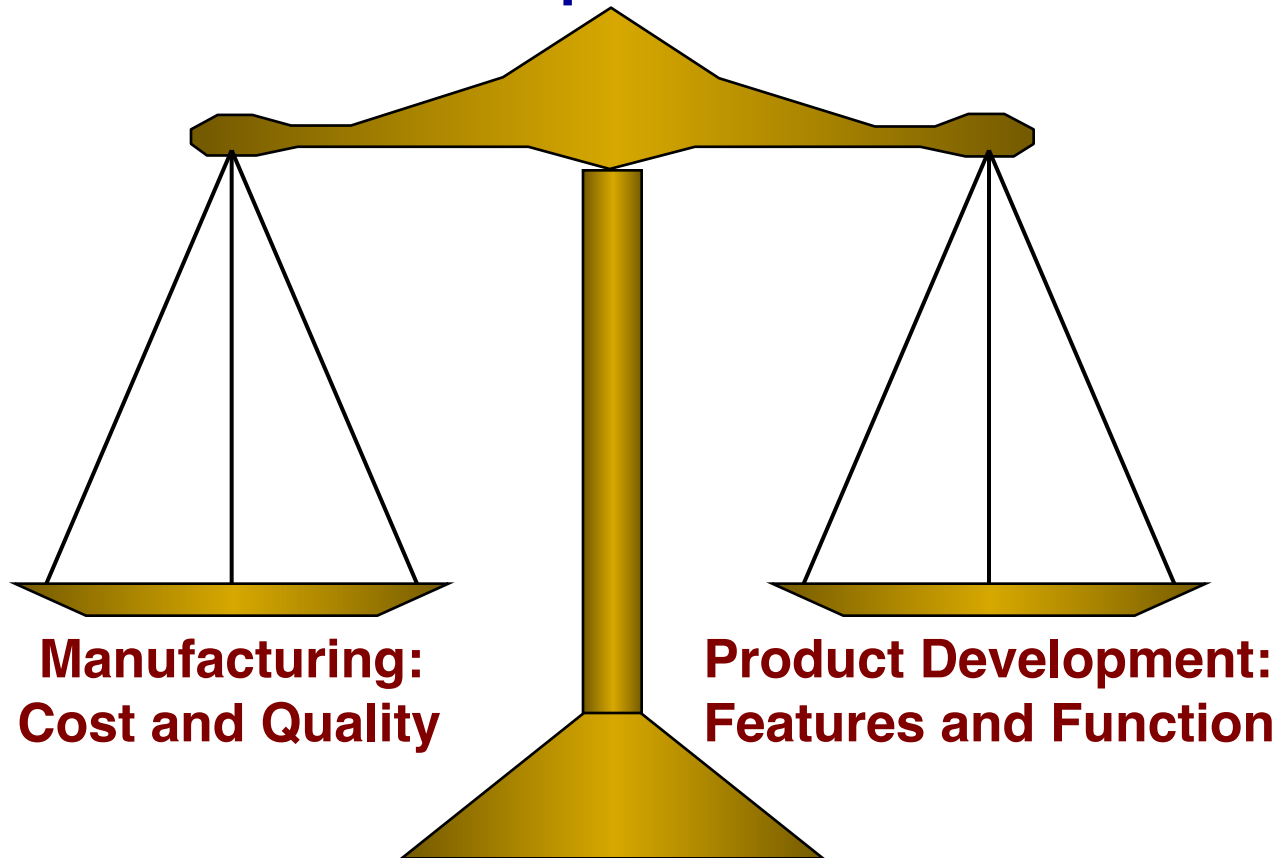- No set timing
- Unpredictable returns
- Long term

Technology Development

- Loosely structured
- Difficult to plan
- Less predictable
- Medium term

Product Development

- Structured methods
- Planned timing
- Predictable outcome
- Short term

Changing Dimensions of Competition

Manufacturing: Cost and Quality

Product Development: Features and Function

Competitiveness today is more than ever based on product development capability.

Creating Value through Product Development:

It's all about the product.

Apple: Simply Better Products

Black & Decker Snake Light

GoodGrips Angled Measuring Cups

Target Prescription Pill Bottle
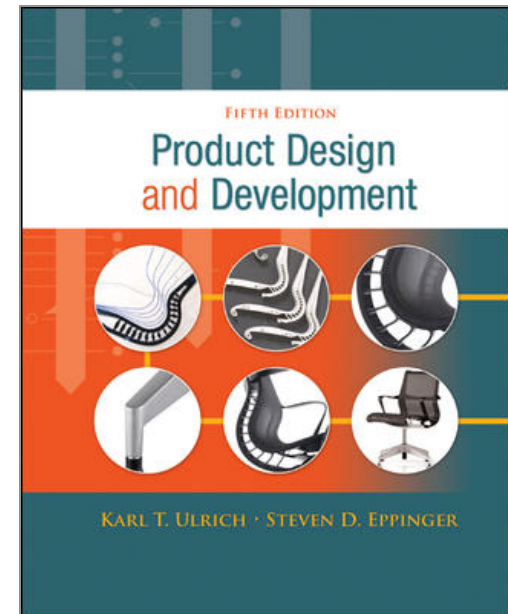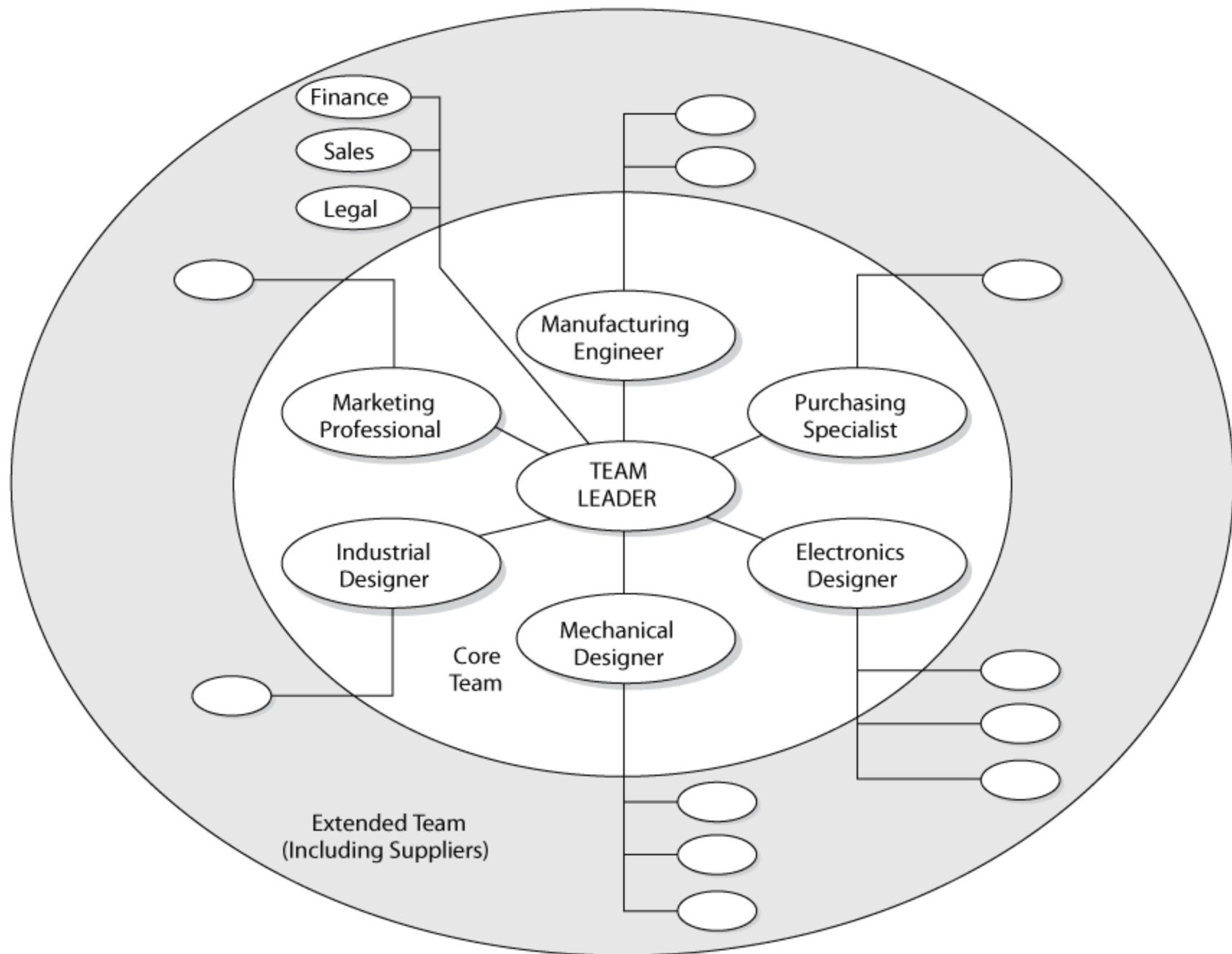
Bodum Pavina Glasses

iRobot Roomba

Textbook

Product Design and Development
Karl T. Ulrich and Steven D. Eppinger
5th edition, Irwin McGraw-Hill, 2012.

Finance

Sales

Legal

Manufacturing Engineer

Marketing Professional

Purchasing Specialist

TEAM LEADER

Industrial Designer

Electronics Designer

Mechanical Designer

Core Team

Extended Team
(Including Suppliers)

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Development Processes and Organizations

Teaching materials to accompany:

*Product Design and Development
Chapter 2*

Karl T. Ulrich and Steven D. Eppinger
5th Edition, Irwin McGraw-Hill, 2012.

Concept Development Process

Mission Statement → **Identify Customer Needs** → **Establish Target Specifications** → **Generate Product Concepts** → **Select Product Concept(s)** → **Test Product Concept(s)** → **Set Final Specifications** → **Plan Downstream Development** → Development Plan

Perform Economic Analysis

Benchmark Competitive Products

Build and Test Models and Prototypes
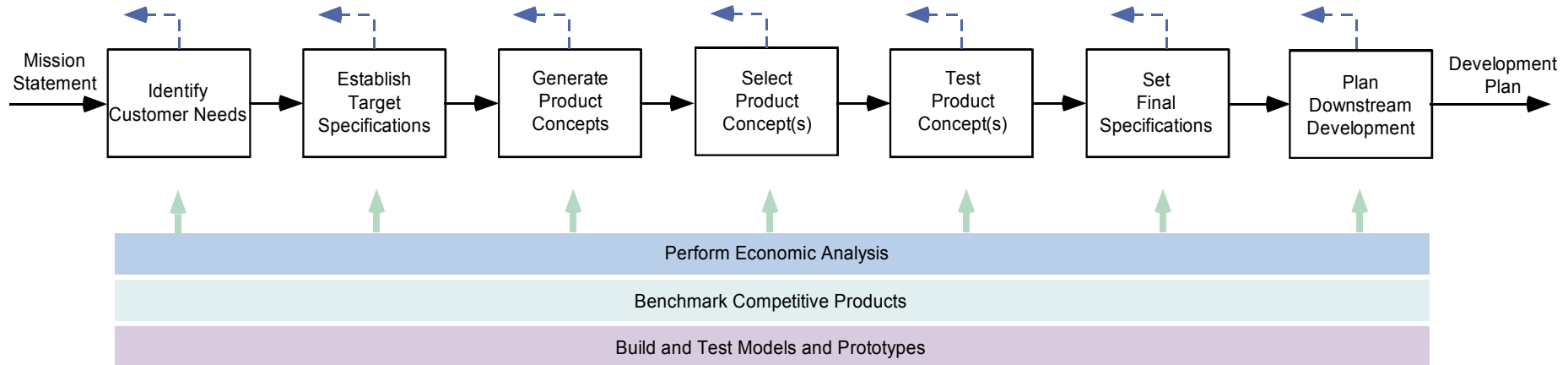
Generic Product Development Process

Planning		Concept Development		System-Level Design		Detail Design		Testing and Refinement		Production Ramp-Up
	Mission Approval		Concept Review		System Spec Review		Critical Design Review		Production Approval	
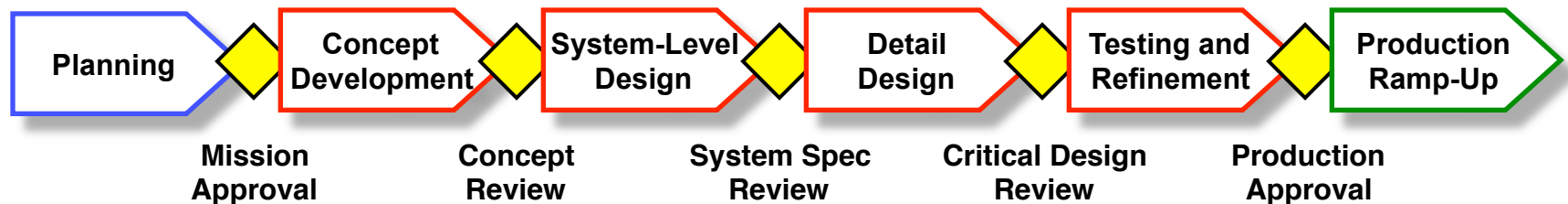
Rapid Iteration PD Process

Planning → **Mission Approval** → **Concept Development** → **Concept Review** → **System-Level Design** → **Cycle Plan Review** → **Design** → **Build** → **Test** → **Cycle Review** → **Production Ramp-Up**

Many Iteration Cycles
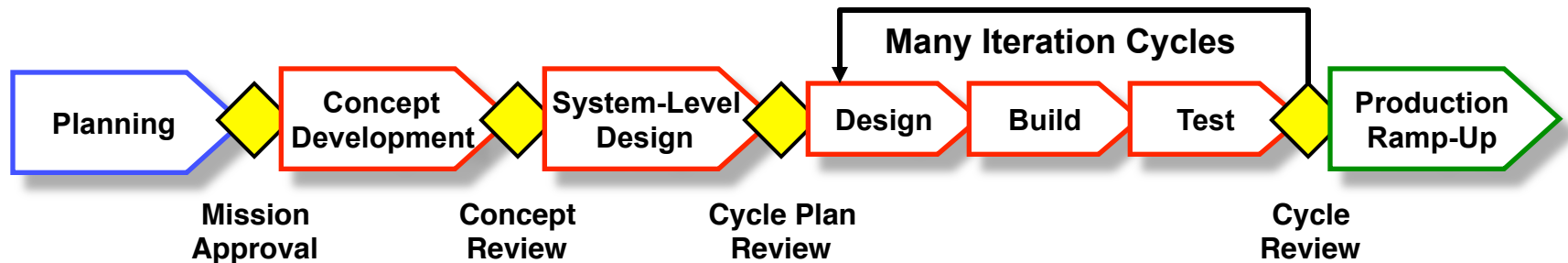
Complex System PD Process

Planning → **Mission Approval** → **Concept Development** → **Concept Review** → **System-Level Design** → **System Review** → [**Design** → **Test**] (×4) → **Integrate and Test** → **Production Approval** → **Validation and Ramp-Up**

Concept Development Process

```
Mission                                                                                                      Development
Statement                                                                                                    Plan
```

| Identify Customer Needs | Establish Target Specifications | Generate Product Concepts | Select Product Concept(s) | Test Product Concept(s) | Set Final Specifications | Plan Downstream Development |

Perform Economic Analysis

Benchmark Competitive Products

Build and Test Models and Prototypes
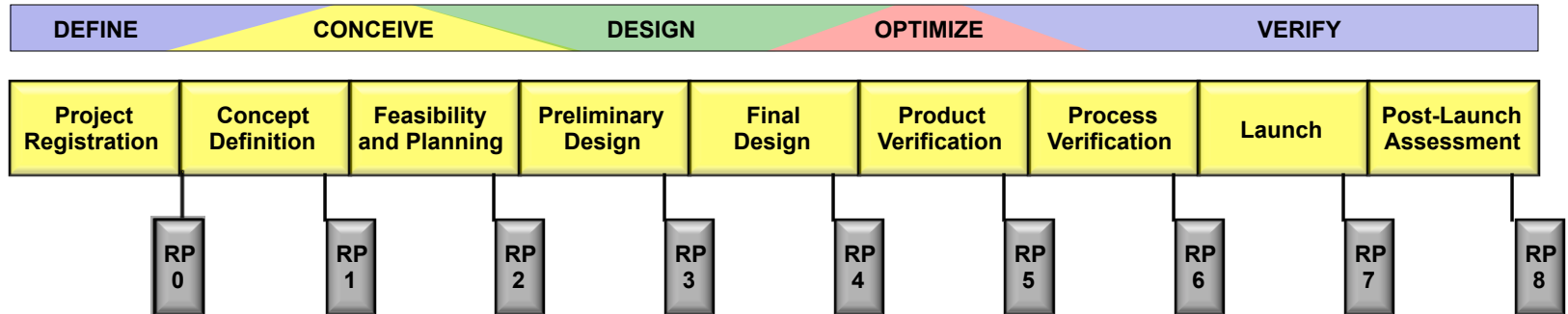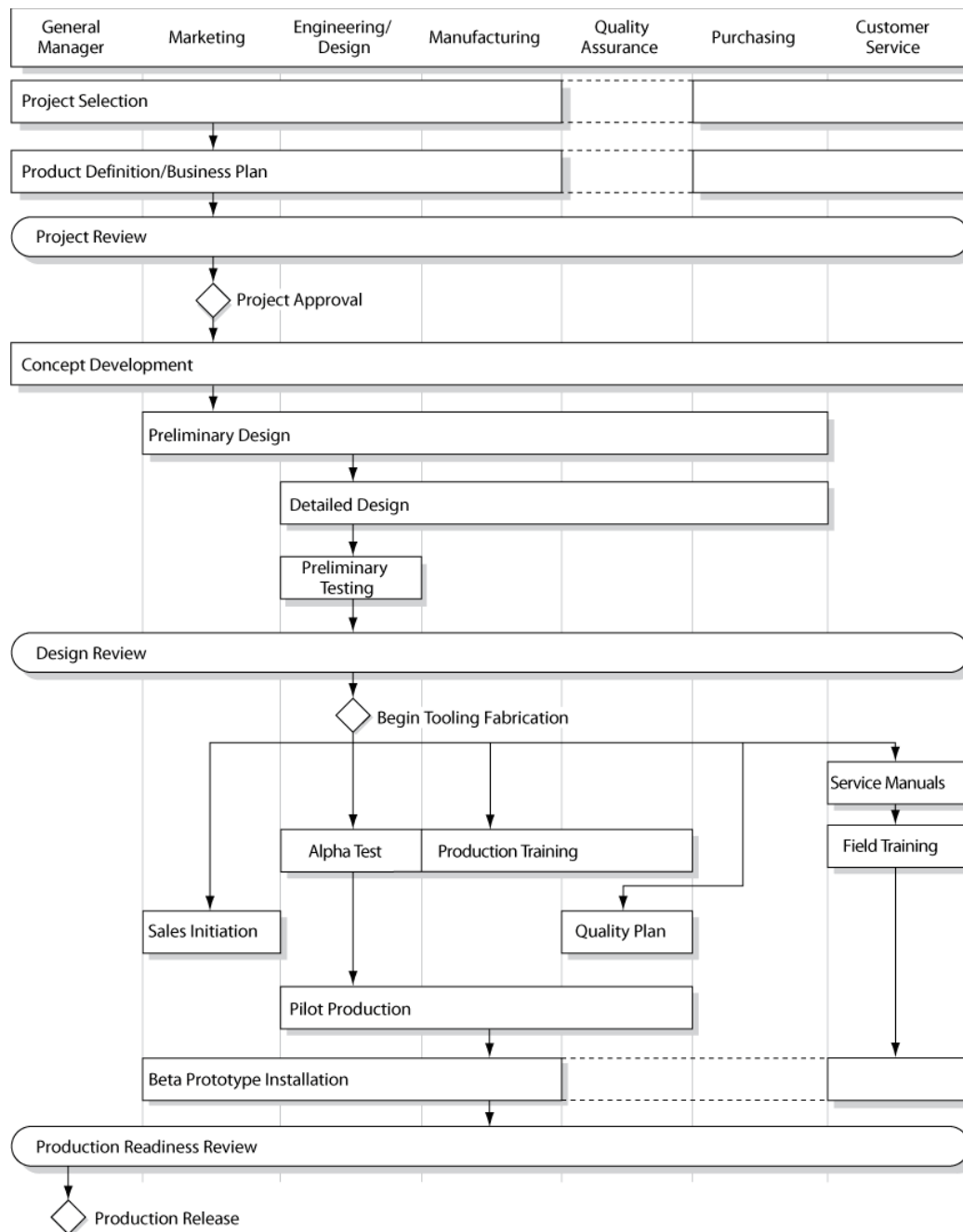
- Front-end of PD need not be a fuzzy process.
- Structured methods exist for each process step (see text chapters 4 to 8).
- This is not strictly sequential -- generally a parallel and iterative process.
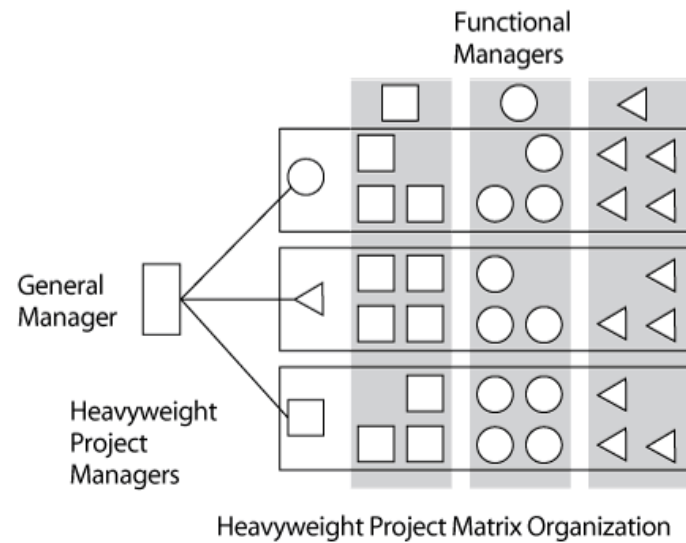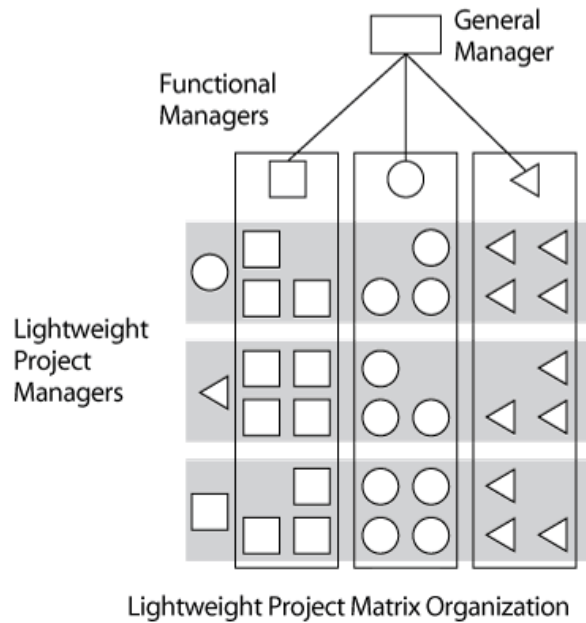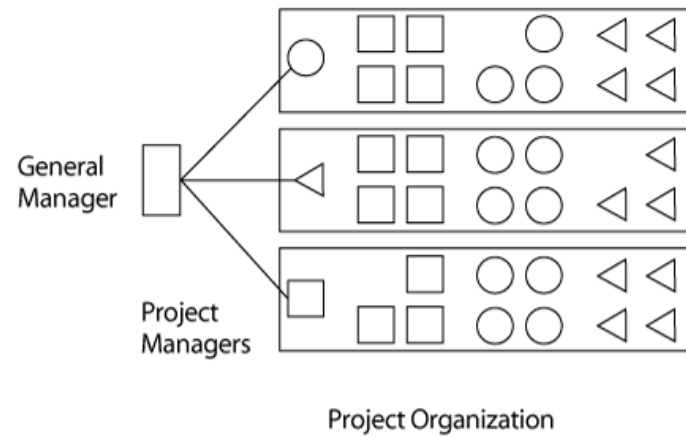
Tyco Product Development Process

DEFINE	CONCEIVE	DESIGN	OPTIMIZE	VERIFY

Project Registration	Concept Definition	Feasibility and Planning	Preliminary Design	Final Design	Product Verification	Process Verification	Launch	Post-Launch Assessment
RP 0	RP 1	RP 2	RP 3	RP 4	RP 5	RP 6	RP 7	RP 8

System is
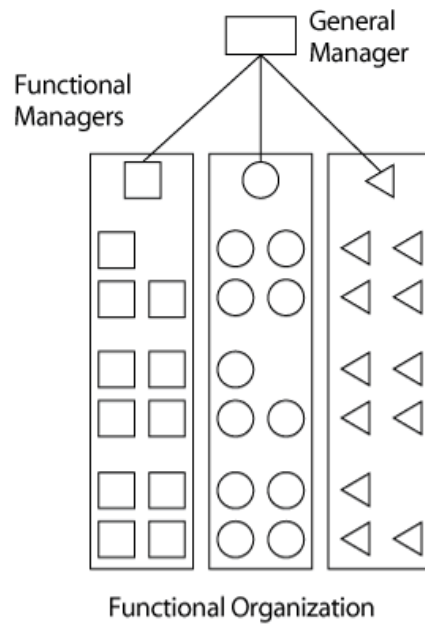Ready to Arm < >

DSC

Tyco Product Development Process

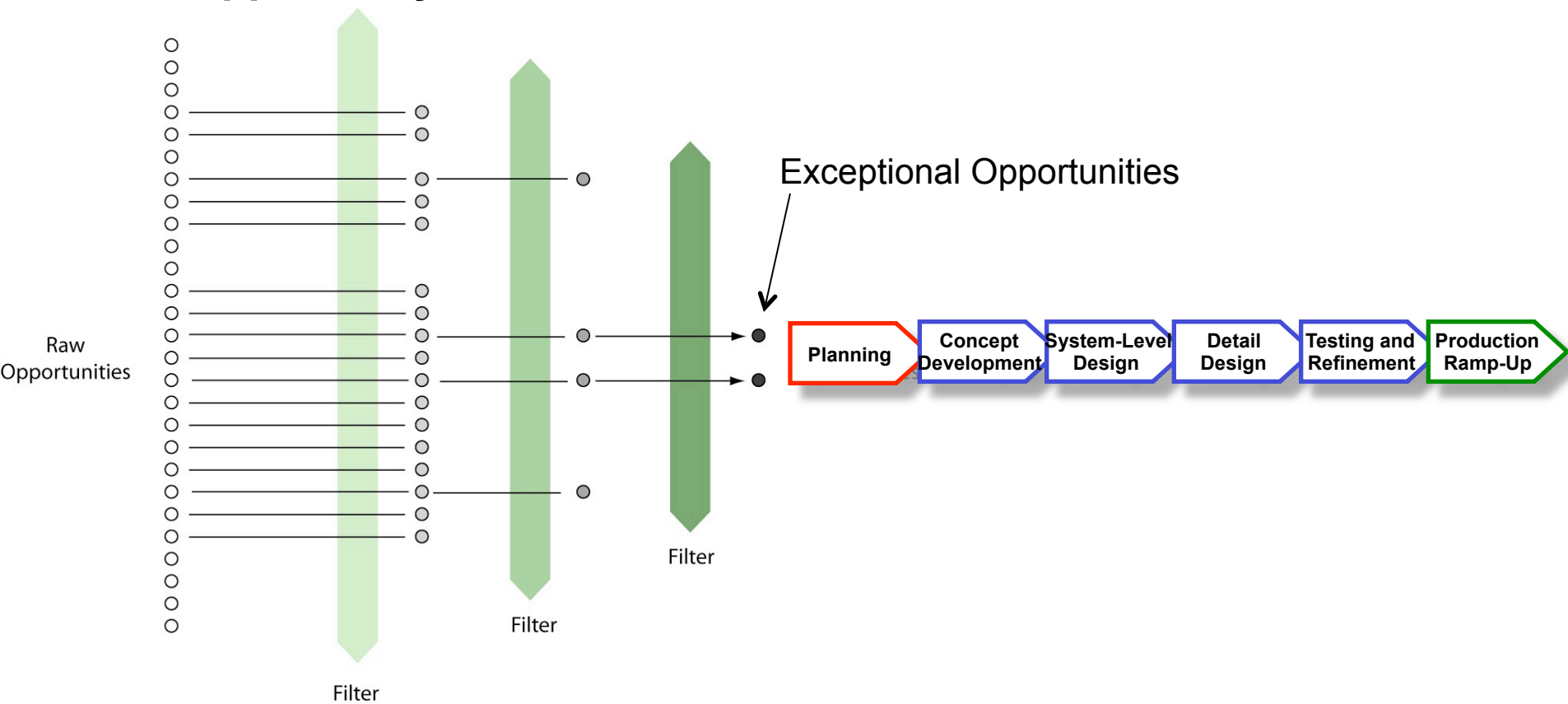| Rally Point Phase	0. Project Registration	1. Concept Definition	2. Feasibility and Planning	3. Preliminary Design	4. Final Design	5. Product Verification	6. Process Verification	7. Launch	8. Post-Launch Assessment
Primary Goal	Define project and business unit needs	Develop project concept and charter	Create product description	Create preliminary detailed design	Detail and optimize design	Demonstrate product performance	Demonstrate process performance	Launch product	Identify lessons learned
Marketing and Sales	Identify customers and market size	Capture voice of the customer	Develop marketing and sales plans	Review concepts with customer		Initialize field trials	Complete field trials	Finalize pricing and sales forecasts	Solicit customer feedback and satisfaction ratings
	Describe competitive features and benefits	Analyze customer needs	Create phase-in and phase-out plans				Finalize training plans	Complete sales and service training	Measure sales vs. forecast
	Identify target cost and price	Document customer needs							Complete phase-in and phase-out
Engineering	Identify project risks	Identify critical-to-quality specs	Create functional specification and performance metrics	Conduct a preliminary design review	Freeze hardware and software design	Finalize design documentation	Obtain regulatory approvals	Finalize product metrics	
		Develop and select concepts	Review concept selection	Build and test alpha prototypes	Complete engineering documentation	Complete beta prototype and field testing			
		Update project risks	Define product architecture	Assess product failure modes	Draft technical documentation	Apply for regulatory approvals			
			Assess technical failures modes		Secure beta prototypes				
Quality Assurance			Create preliminary test plan		Test beta prototypes for robustness	Complete quality assurance testing	Conduct process verification testing		
Manufacturing				Begin manufacturing process development	Finalize bill of materials (BOM)	Update manufacturing control plans	Run manufacturing pilots		Register obsolete and scrap products
				Conduct a preliminary manufacturing process review	Develop manufacturing control plans		Finalize manufacturing control plans		
Purchasing				Create a supplier participation matrix	Identify long lead-time items		Verify supply chain readiness		
				Assess suppliers for certification					
Legal		Search patents	Identify trade compliance issues	Identify potential patents	Prepare patent applications	Assure trade compliance			
FInancial	Prepare preliminary business case	Refine business case	Complete financial package						Monitor return on investment
Project Management	Identify project timing, resources, and capital	Assess team capabilities/skills	Plan integrated product development schedule	Update RP1-2 deliverables	Update RP1-3 deliverables	Update RP1-4 deliverables	Update RP1-5 deliverables	Finalize all deliverables	Document best practices
	Prepare RP0 checklist & submit for approval	Identify development team members	Assign a project manager	Prepare RP3 checklist & submit for approval	Prepare RP4 checklist & submit for approval	Prepare RP5 checklist & submit for approval	Prepare RP6 checklist & submit for approval	Finalize launch plans and documentation	Prepare RP8 checklist & submit for approval
		Select a Rally Point process variant	Update RP1 deliverables					Update RP1-6 deliverables	
		Prepare RP1 checklist & submit for approval	Prepare RP2 checklist & submit for approval					Prepare RP7 checklist & submit for approval	

General Manager	Marketing	Engineering/ Design	Manufacturing	Quality Assurance	Purchasing	Customer Service

Project Selection

Product Definition/Business Plan

Project Review

◇ Project Approval

Concept Development

Preliminary Design

Detailed Design

Preliminary Testing

Design Review

◇ Begin Tooling Fabrication

Service Manuals

Alpha Test — Production Training

Field Training

Sales Initiation

Quality Plan

Pilot Production

Beta Prototype Installation

Production Readiness Review

◇ Production Release

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Functional Organization

Project Organization

Lightweight Project Matrix Organization

Heavyweight Project Matrix Organization

From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Opportunity Identification

Teaching materials to accompany:

*Product Design and Development
Chapter 3*

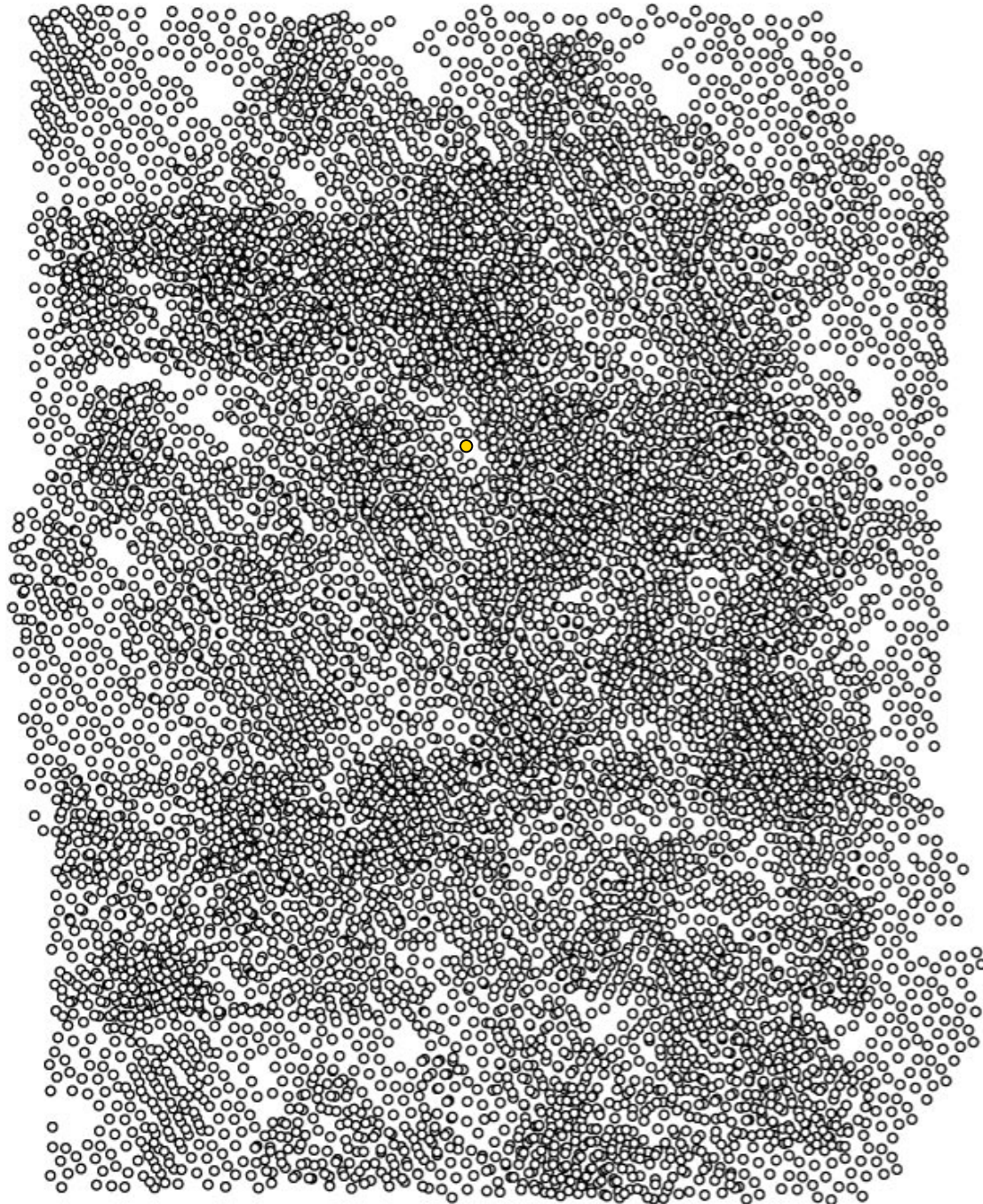Karl T. Ulrich and Steven D. Eppinger
5th Edition, Irwin McGraw-Hill, 2012.

Opportunities Begin the Product Planning and Product Development Processes

Opportunity Tournament

Exceptional Opportunities

Raw Opportunities

Filter

Filter

Filter

| Planning | Concept Development | System-Level Design | Detail Design | Testing and Refinement | Production Ramp-Up |

Pharmaceutical Drug Development

8-12 years
$500 million - $1 billion

ZŌCOR
(SIMVASTATIN)

1 new drug

10,000 newly discovered compounds
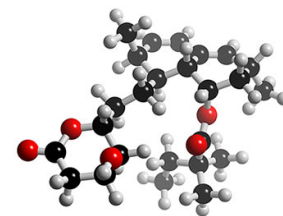
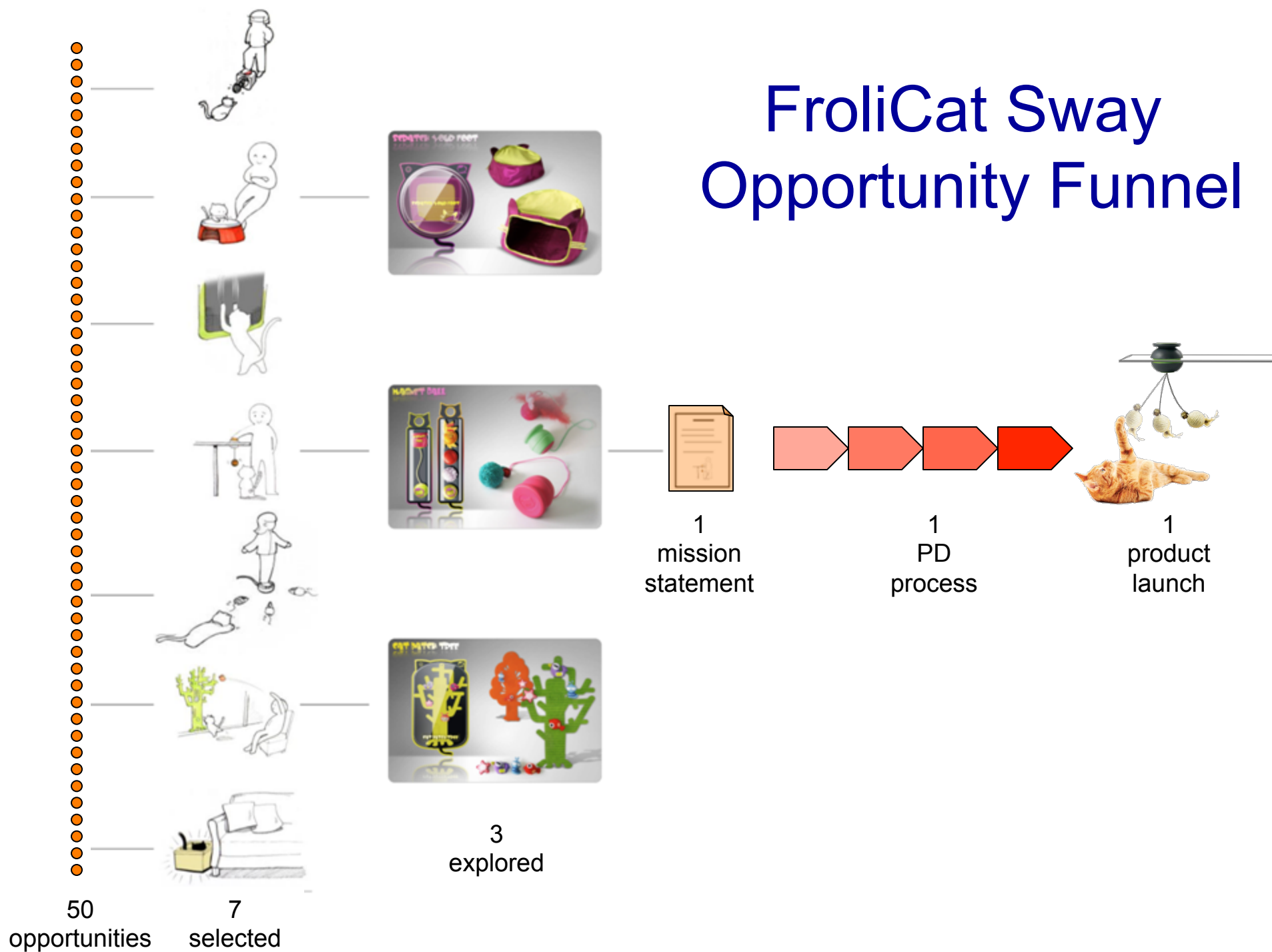# Hollywood Film Studios
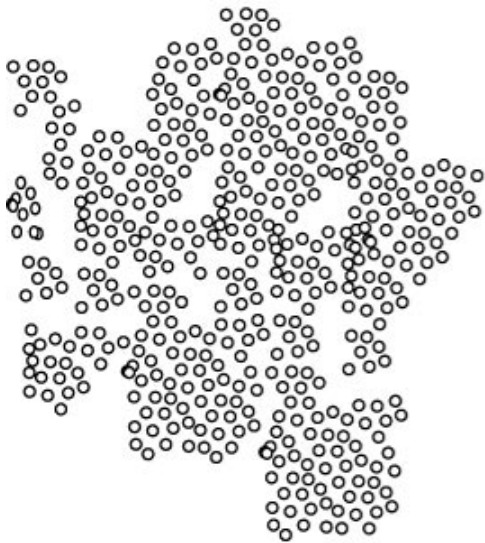
500 "pitches"
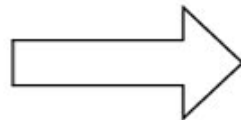
→ 3-5 years
$50-200 million

1 new feature film

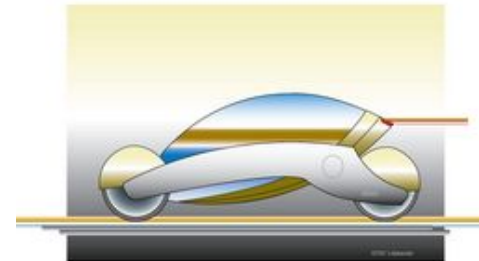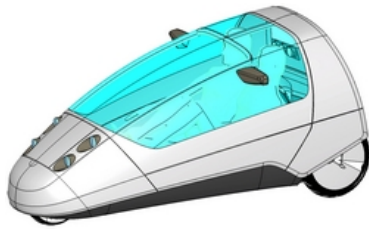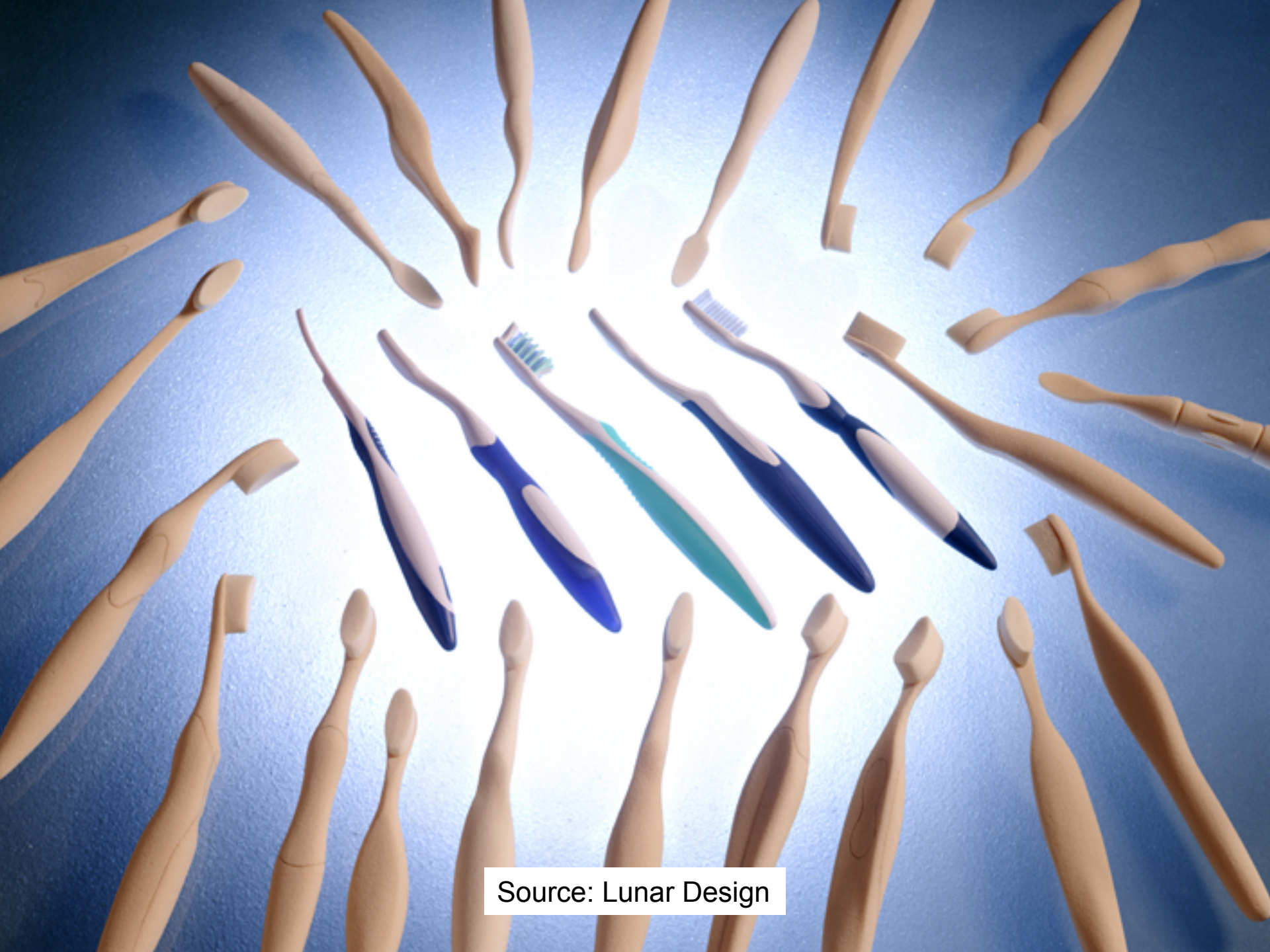# Opportunity Identification Example

FroliCat™
All About Fun
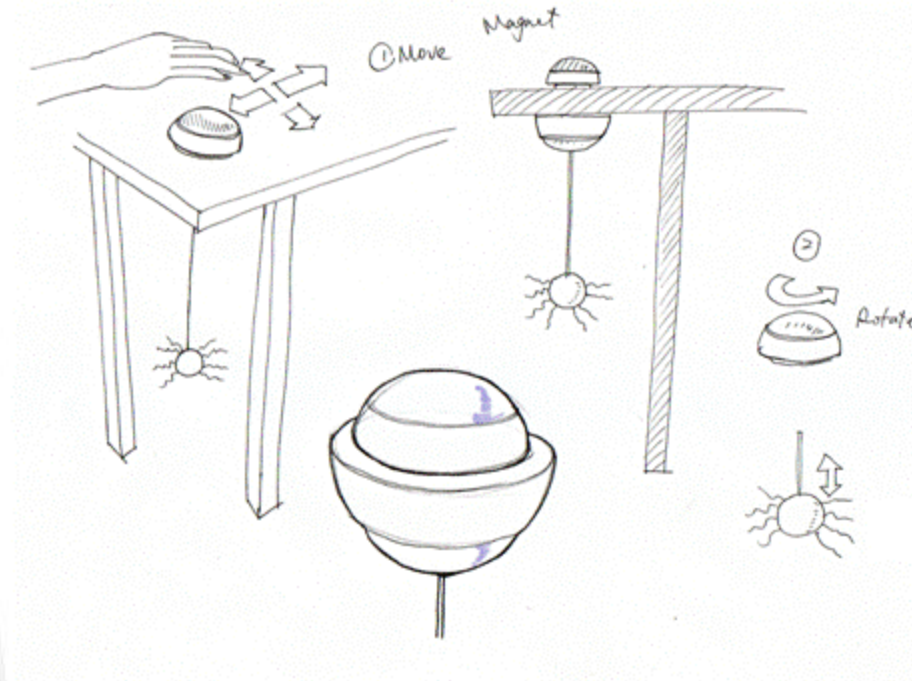
FroliCat Sway
Opportunity Funnel

50 opportunities

7 selected

3 explored

1 mission statement

1 PD process

1 product launch

Automobile Concepts

Source: Lunar Design

Product Naming Tournament

Initial Ideas	Best Ten	Best Three	Final Name
AstroPong	Catapong	Catapong	Xpult
Catapong	Catapulooza	Varipult	
Catapulooza	Experipult	Xpult	
Experipult	FlingThing		
FlingThing	Funpult		
Fooz	Hurlicane		
Funpult	PingFling		
Hurlicane	Slingcat		
Hurlitzer	Varipult		
LearningLever	Xpult		
PennPong			
Physazz			
PingFling			
Pongit			
Slingcat			
Swish			
TheCatapult			
Varipult			
Xpult			

The Funnel in Various Industries
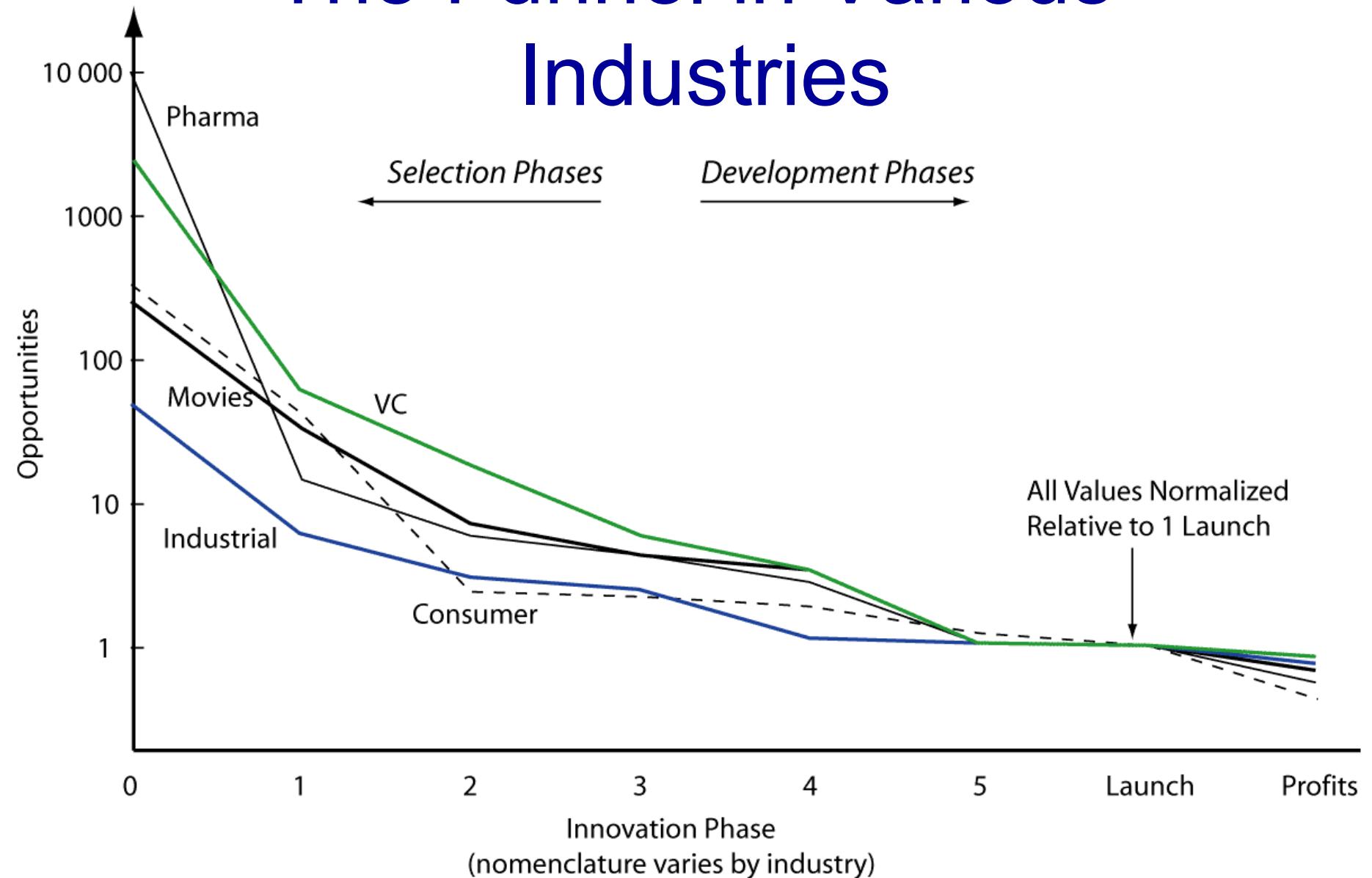
Where do opportunities come from?

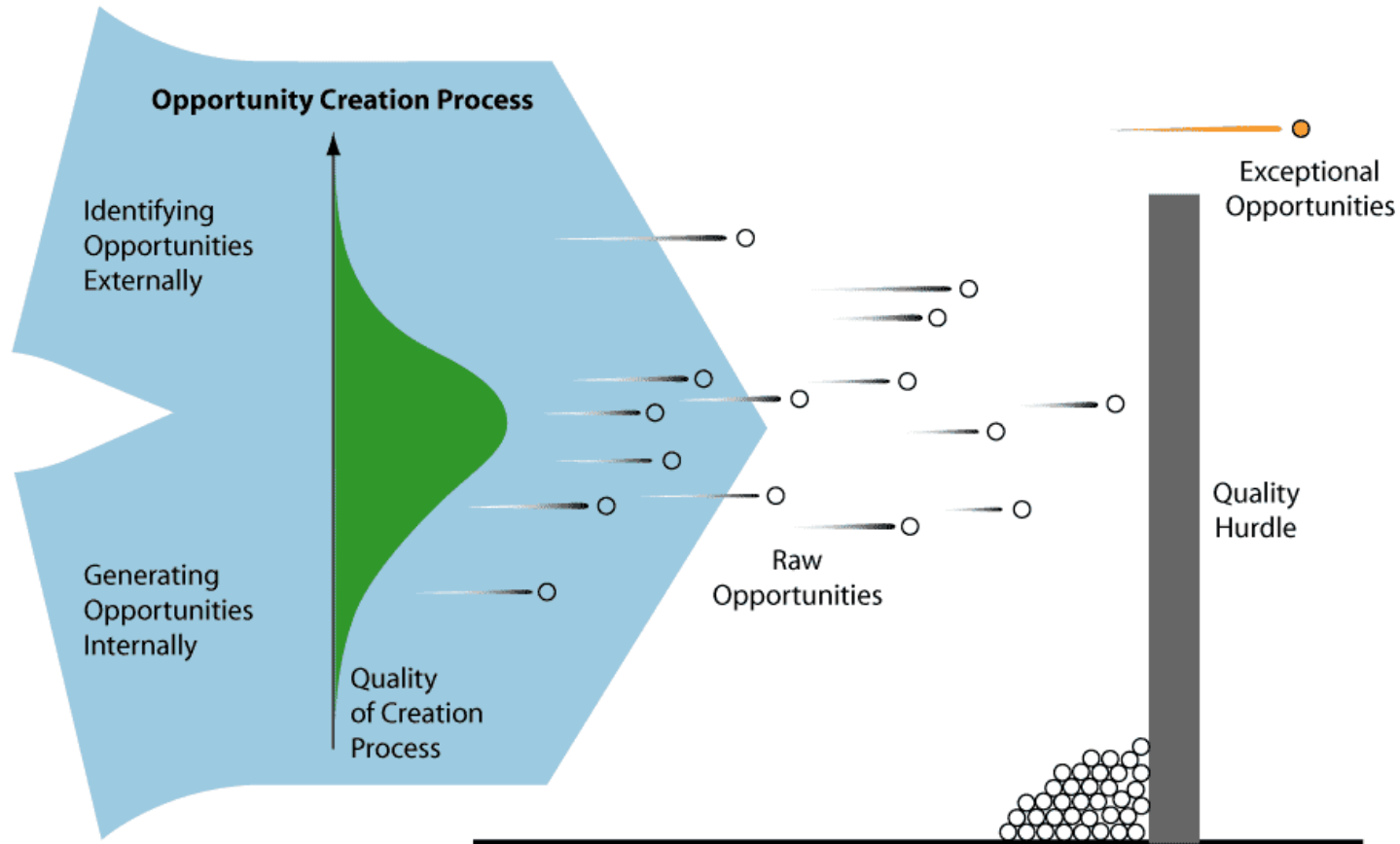|	
internally generated	46 %
customer	23 %
competitive product	11 %
sales force	5 %
university	4 %
independent inventor	4 %
distribution partner	3 %
other partner company	2 %
supplier	2 %
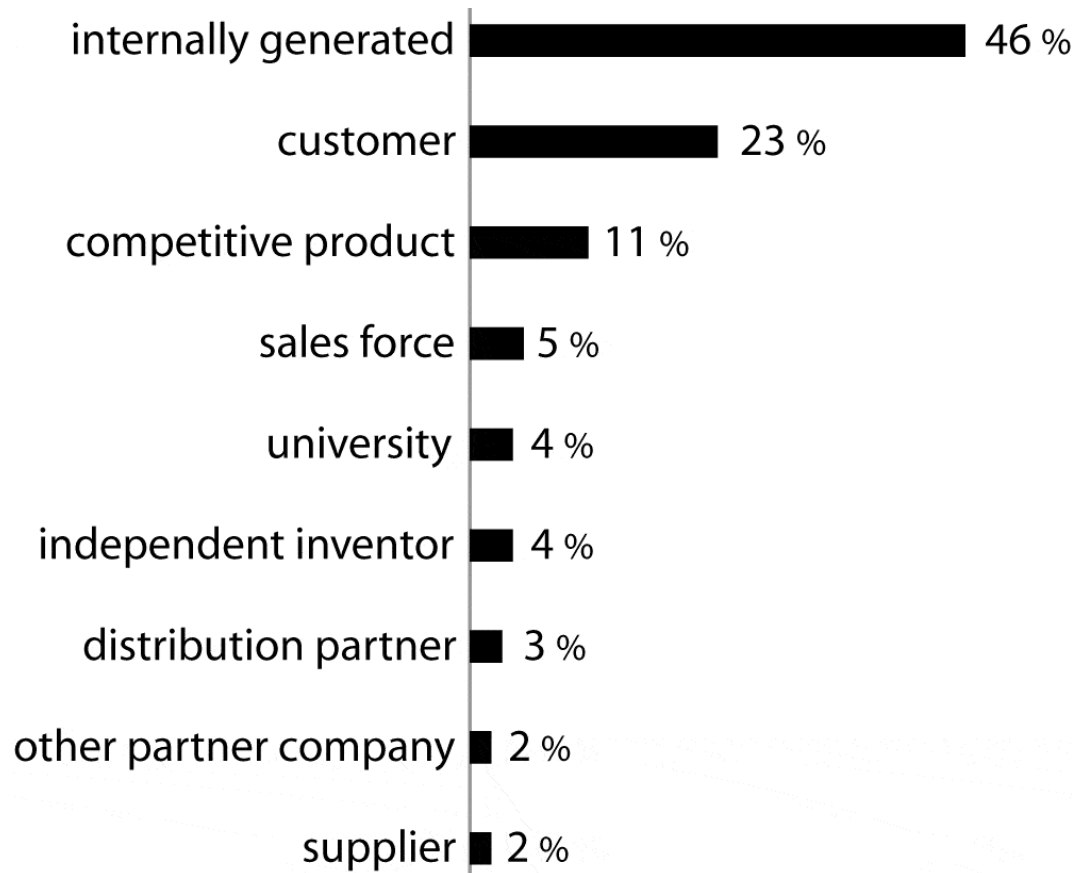
Source:
Terwiesch and Ulrich survey of 524 managers in diverse service and product industries, October 2006.

What drives the quality of the opportunities?

- Mean quality of the opportunity identification process.
- Variance in quality of the opportunity identification process.
- Number of "draws" from the opportunity identification process.
- Accuracy of discerning the best subset of opportunities generated.

Project Down selection:
The PD Process Funnel

| Planning | Concept Development | System-Level Design | Detail Design | Testing and Refinement | Production Ramp-Up |