Business Innovation in Optics and Photonics

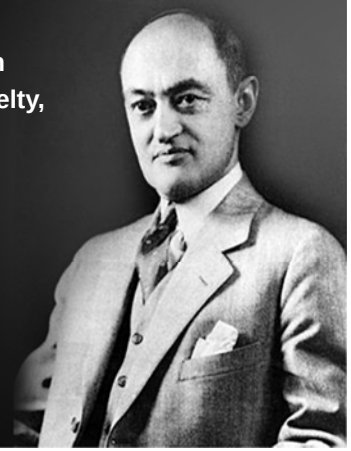
Course Section 7

Project Design and Design to Cost

Dr. Markus Weber
Carl Zeiss AG

What Innovation is really about

Innovation is the implementation of a technical or organizational novelty, not just its invention. *



*** J. A. Schumpeter**
1883-1950

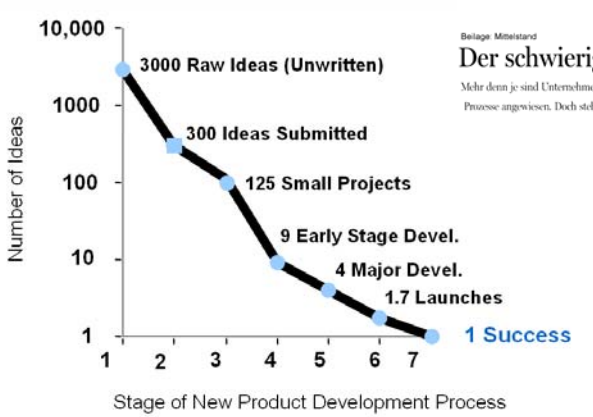
Different Types of Innovation

But unfortunately, true Innovations are not always easy to discover

» Nobody wants to send text messages.
You can call at any time. « *

*** Bill Gates, 1994**

Or: The road to innovations is paved with roadblocks – *„Innovation-Funnel“*



Handelsblatt

Beilage: Mittelstand

Der schwierige Weg zur Innovation

Mehr denn je sind Unternehmen auf neue Produkte, Dienstleistungen und Prozesse angewiesen. Doch stehen sie sich bei der Suche selbst im Weg.

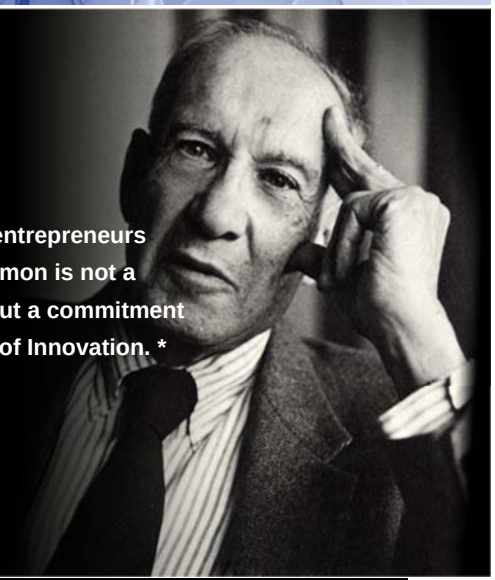
Quelle: Stevens, Burley: 3000 raw ideas = 1 commercial success, Research Technology Management 1997, Handelsblatt 2007

Difference in profitability that proponents compared to opponents of a specific value implemented with their projects or products

Value	Difference in profitability
Open to the outside	+ 178%
Diversity in the team	+ 162%
Favor radical, disruptive innovation	+ 148%
Short time to prototype / market	+ 91%
Creativity based on factual competence	- 54%
Stick to the tried and true	- 58%

Source: Harvard Business Manager, German Edition, January 2006

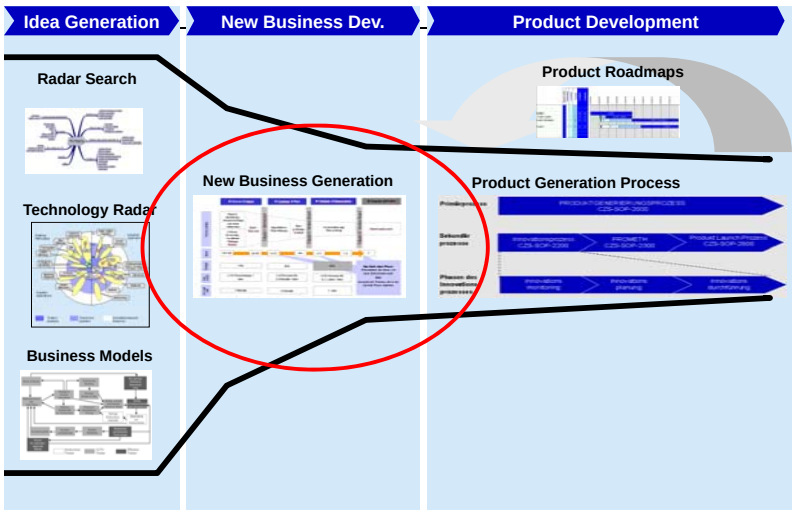
The Discipline of Innovation
Innovate or Die



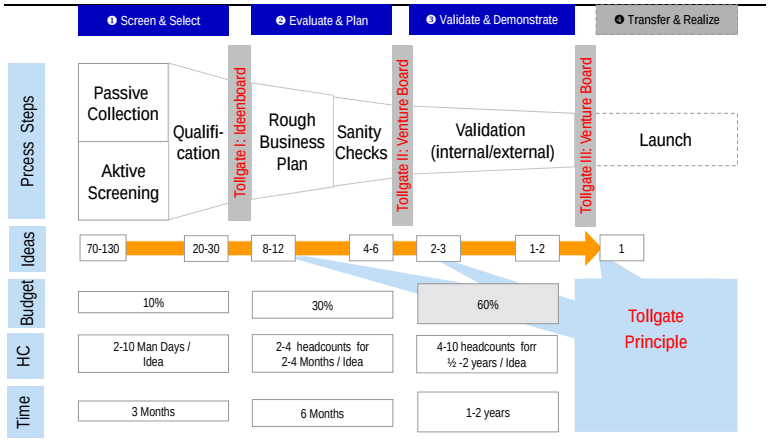
What all the successful entrepreneurs I have met, have in common is not a certain kind of personality but a commitment to the systematic practice of Innovation. *

*** P. F. Drucker, Famous Economist 1909-2005**

Structured Innovation Process is Needed to Focus Resources



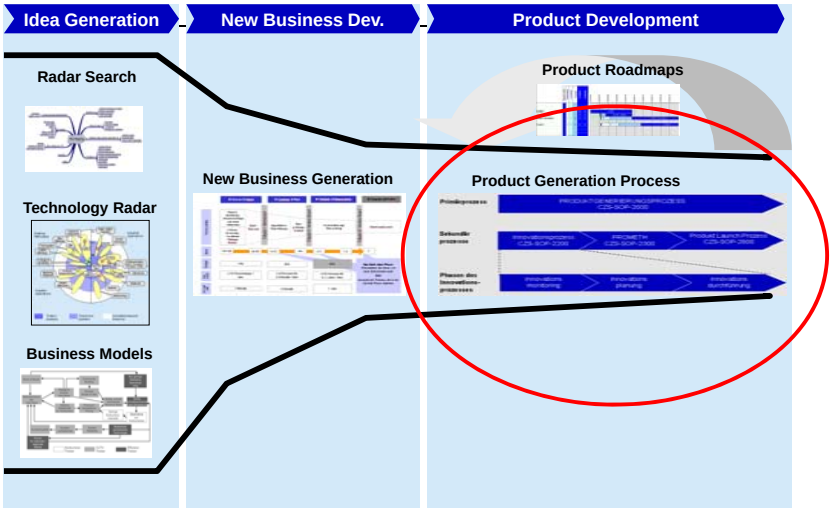
New Business Generation Process Structures „Fuzzy Front End“



Tollgate II criteria allow focused discussions in the Carl Zeiss Venture Board

	Criterion	Fulfill-ment	Comments
Business model	More attractive than alternatives	○	Criteria are not strict exclusion criteria, but the evaluation of the degree of criteria fulfillment serves to focus the discussion in the Venture Board
	Unique selling point for CZ	○	
	Unique selling point is sustainable	○	
	Letter of intent from lead customer	○	
Mentor-ship	Suitable CZ SBU	○	
	Heads of divisions/business groups appointed as mentors	○	
Business Case	Initial sales in 2 years from Tollgate III onwards	○	
	Sales potential CZ > €50M	○	
	Target EBIT margin > 5%	○	
	12-year DCF > 0	○	
Project planning	Project team appointed	○	
	Measures for unfamiliarity risks	○	
	Validation milestones for uncertainty risks	○	

Structured Innovation Process is Needed to Focus Resources



Topic I: How to <u>manage</u> an R&D project

- Define term “R&D project”:
  - Show Stage-Gate-Process and Focus on product R&D part
  - Input: Market Driven Requirement Spec
  - Output: Hand-over of final product design to production
- Illustrate Continuous cross-functional involvement of Product Management, Marketing, Production, Purchasing, Service
- Introduce R&D Project KPIs: Time, Budget, Features
- Show project planning and tracking of KPIs: Activities, Work packages, Interfaces, Milestones, Critical Path

From „design“ to „manage“ an innovation project

The „Fuzzy Front End“ – The Definition Phase

What is the “Fuzzy front End” ?

- Fuzzy !
- It is when the product idea is born and the business rational investigated, when market opportunities really exist !
- It is when we actually create a business !

“Fuzzy Front End” typically lasts a long time !

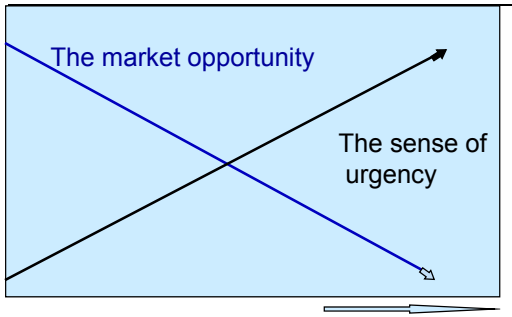
A month delay in the “Fuzzy Front End” has the same cost as a month delay in the “End Phase” of a project !!

It’s a cheap place to shop, i.e. it’s easier to get a reduction of cycle time here than it is to get it anywhere else !!!

Be aware: The market clock is ticking without mercy !

So it should be extremely important, but what we see is an urgency paradox !

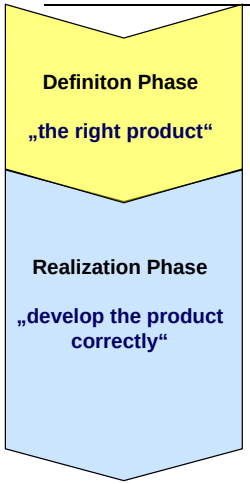
Urgency Paradox



The real money is wasted in the beginning of the PGP !

Excercise: Calculate the cost of delay in a business plan !

Product Development Process



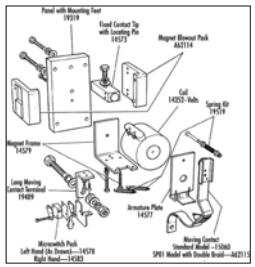
Phase	Responsible	Involved
Market research phase	Gen. Mgr.	Marketing Sales R&D
Concept Phase	PM	Marketing Sales Finance R&D
Planning Phase	Project manager	R&D PM, QA Service Manufacturing
Development Phase I (Prototype)	Project manager	R&D PM, QA Service Manufacturing
Development Phase II = design transfer	Project manager	R&D Manufacturing QA, Service PM
Product Introduction	Gen. Mgr.	PM Marketing Sales Service

Topic II: Design to Cost and how to achieve it

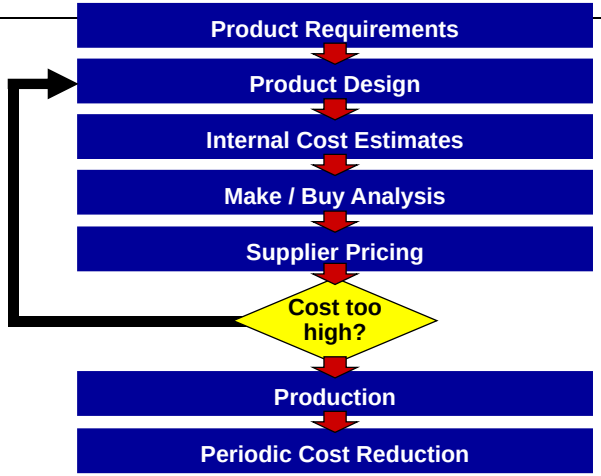
- Step 1: Determine target cost:
  - Benchmarking with comparable products
  - Use case evaluation, price sensitivities, margin structures
  - Output : → target cost
- Use cost split of comparable systems to break down targets
- Identify cost levers and focus on them
- Start with design to cost already in concept phase
- Regular review cost-performance trade-offs and update requirement specs (various tools like conjoint analysis)
- Design to Cost and suppliers/outsourcing
- Platforms

Basis of Product Cost

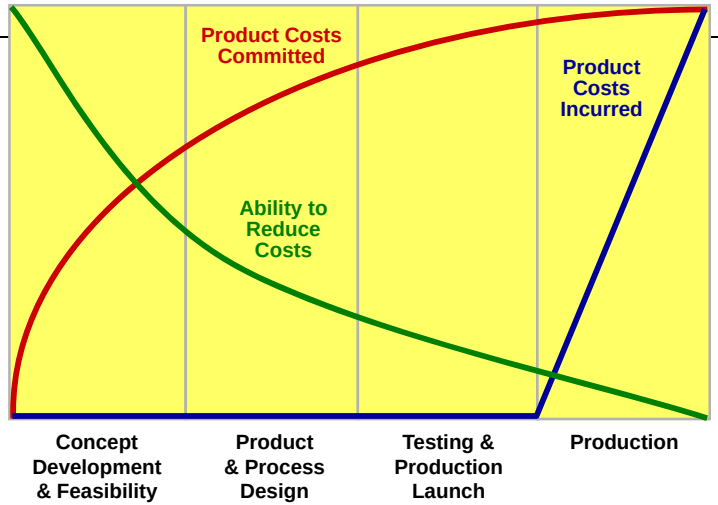
Product Design + **Process Design** = **Product Cost**



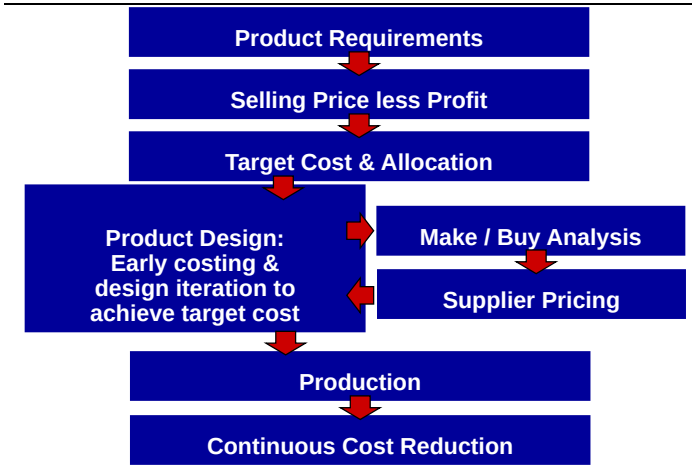
Traditional Cost Management



Design Impact on Product Cost



Target Costing and Design to Cost



Target Costing and Design to Cost (DtC)

Target Costing is the front end process of assessing the market, establishing a target price, deriving a target cost & planning profits

Design-to-Cost is the backend process of designing products to achieve the target cost and planned profits

Achieving Design To Cost

- Concept Development
- Assembly Design
- Part Design
- Process Design

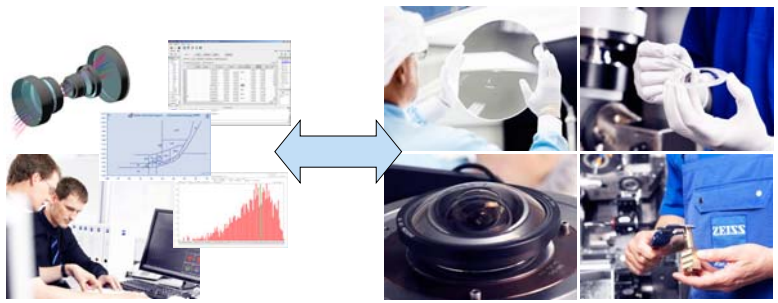
Design to cost actions can be taken in each stage of the development process

Achieving Design to Cost One Must Address the Entire Supply Chain

Tier 2 Supplier	Tier 1 Supplier	Manufacturer	Distributor/ Retailer	Customer
• Early supplier involvement • Realistic specification • Design for Manufacturability • Function analysis • Product cost models		• Product cost models/cost estimating for decision-making • Explore concept & design alternatives • Function analysis • Design for Manufacturability, Assembly & Test • Process Automation & Integration • Process Re-Engineering	• Create efficient distribution system • Direct sales • Packaging • Sourcing to minimize logistics	• Understand customer needs & priorities • QFD • Conjoint analysis

Design for Manufacture means..

- To know the technological capabilities of different manufacturers
- To now advantages and disadvantages of technologies
- To develop devices (design and tolerances) which are using this advantages and are not sensitive to disadvantages



Suppliers & DtC

- Get key suppliers involved early - use their expertise in early stages with evaluation of design alternatives
- Understand their process capabilities
- Obtain and apply their DFM/A guidelines
- Work with suppliers to develop cost models that both organizations can jointly use

Establish Target Price & Cost

Maximizing Value in DtC

Maximizing value - finding the optimum mix of function and capability

How do you determine which features and functions are of interest to customers ?

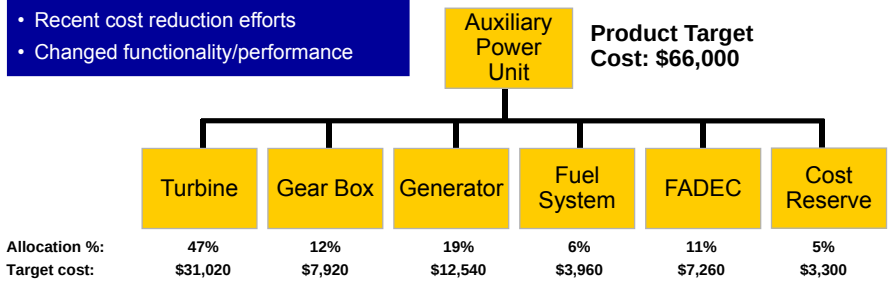
How much they are worth to customers?

Conjoint Analysis

- A methodology for exploring subjective customer views on the relative value of product features
- Avoids direct questioning, e.g., “what are you willing to pay for this feature?”
- The customer is asked what they are willing to pay for a particular product feature indirectly by choosing a preference for a product with a set of features at a price
- The resulting analysis show directly the contribution of each product feature to the total product utility
- Conjoint analysis can be used to determine to what extent a product’s perceived value changes if some particular product feature is modified

Allocate Target Cost to Provide Targets for Designers and to Monitor

Allocate based on:
- Last generation product
- Preliminary cost estimates
- Cost reduction %
- Consideration of new technology
- Recent cost reduction efforts
- Changed functionality/performance



	Turbine	Gear Box	Generator	Fuel System	FADEC	Cost Reserve
Allocation %:	47%	12%	19%	6%	11%	5%
Target cost:	$31,020	$7,920	$12,540	$3,960	$7,260	$3,300

Bill of Material (BoM)

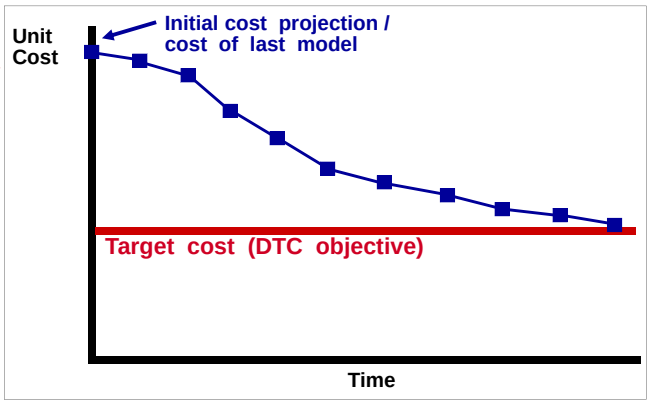
☑ Show cost information Sort data by clicking on field

									Target Cost		Material: Current Est./Quoted		Labor: Current Estimate	
BOM Level	Parent Part Number	Item Part Number	Description	Qty Per	Unit of Meas.	Make/ Buy/Std	Rev. Level	Revision Date	Unit Cost	Extended	Unit Cost	Extended	Unit Cost	Extended
1	99905	57740	MANUFACTURED ASSY Upconverter	1	EA	Make	D	15-Oct-03	0.0000	0.0000	0.0000	0.0000	4.67	4.67
2	57740	57741	MACHINED PART HOUSING UPCONVERTERERTER	1	EA	Make	C	27-Aug-03	0.0000	0.0000	84.7300	84.7300	1.36	1.36
2	57740	57742	MACHINED PART Upconverter SUB-COVER	1	EA	Make	F	26-Aug-03	0.0000	0.0000	15.4900	15.4900	0.33	0.33
2	57740	57765	MACHINED PART COVER REAR 1ST CONV	1	EA	Make	F	26-Aug-03	0.0000	0.0000	17.9600	17.9600	0.15	0.15
2	57740	59217	MACHINED PART GND PIN EXT PRESS FIT	6	EA	Make	C	13-May-03	0.0000	0.0000	7.3200	43.9200	0.28	1.68
2	57740	60373	MANUFACTURED ASSY CARRIER, UPCONVERTER VIRGO	1	EA	Make	F	25-Sep-03	0.0000	0.0000	106.7700	106.7700	3.58	3.58
2	57740	60855	MANUFACTURED ASSY Upconverter COVER ASSY	1	EA	Make			0.0000	0.0000	21.4400	21.4400	3.66	3.66
2	57740	20-135	TRANSISTOR,NPN 51,10V	1	EA	Buy			0.0000	0.0000	0.1800	0.1800	0.00	0.00
2	57740	230-213	FILTER,EMI,FEEDTH 100P,80/-20%,200V,SPEC	11	EA	Buy			0.0000	0.0000	2.3300	25.6300	0.00	0.00
2	57740	57721-3	PC ASSY UpcnvtrTR BLK BIAS MOD.	1	EA	Make			0.0000	0.0000	38.8600	38.8600	0.00	0.00
2	57740	900-495	SCREW,SOCKET HD CAP,0-80,.125 HEXSST	13	EA				0.0000	0.0000	0.0250	0.3250	0.00	0.00
2	57740	905-2623	SCREW,PAN,PHIL,PCHL,M3 M3X10MM,PHIL,PNHD,SST	15	EA				0.0000	0.0000	0.0260	0.3900	0.00	0.00
2	57740	K100	PRODUCT K-CONNECTOR GLASS BEAD K	3	EA				0.0000	0.0000	0.7700	2.3100	0.00	0.00
2	57740	K102F	PRODUCT FEMALE LAUNCHER CONNECTO	3	EA				0.0000	0.0000	1.9700	5.9100	0.00	0.00
								Totals:		987.0000		979.5750		67.83

Source: PD-Trak, www.pd-trak.com

Target Cost		$1,696.18								
	Target Cost Alloc.		Current Cost Estimate							
Assembly/Cost Element	Alloc%	Alloc TC$	11/30/1999	Var%	12/31/1999	Var%	1/31/2000	Var%	2/28/2000	Var%
Top Nozzle										
Adaptor Plate Prep	2.0%	$33.92	51.73	52%	51.73	52%	51.73	52%	51.73	52%
Spring Clamp Prep	0.5%	$8.48	14.92	76%	14.92	76%	14.92	76%	14.92	76%
Weldment Assy/Machining	14.0%	$237.47	288.12	21%	288.12	21%	288.12	21%	288.12	21%
Nozzle Assembly	2.0%	$33.92	71.05	109%	71.05	109%	71.05	109%	71.05	109%
Insert Preparation	0.5%	$8.48	14.87	75%	14.87	75%	14.87	75%	14.87	75%
Skelaton Assembly	2.0%	$33.92	53.07	56%	53.07	56%	53.07	56%	53.07	56%
Material Cost	58.0%	$983.78	1298.87	32%	1197.50	22%	1197.50	22%	1038.20	6%
Scrap	18.0%	$305.31	313.90	3%	313.90	3%	313.90	3%	313.90	3%
Warranty Cost Diff.	3.0%	$50.89	100.00	97%	100.00	97%	100.00	97%	100.00	97%
Allocation/Total Cost 1	100.0%	$1,696.18	$2,206.53	30%	$2,105.16	24%	$2,105.16	24%	$1,945.86	15%

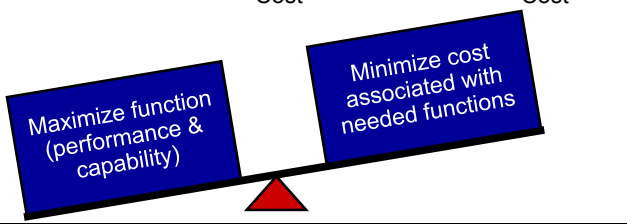
Achieving the Objectives by Monitoring



Value/Function Analysis

- Structured approach to defining a problem, gathering data, brainstorming & developing improvements in value
- Analyze the function performed by an item & relate component / mechanism costs to the functions they perform
- Consider how to avoid the need for functions and find lower cost ways to perform functions

$$\text{VALUE} = \frac{\text{Performance \& capability}}{\text{Cost}} = \frac{\text{Function}}{\text{Cost}}$$



Defining Functions

Function: an intent or purpose that a product is expected to perform

- Describe functions in the simplest terms to better think in terms of the abstract
  - Overcome psychological inertia and think more broadly about how the function can be performed
  - Think of design in terms of functions to be performed rather than mechanisms to accomplish a function
- Verb-Noun description of each function
  - Use active vs. passive verbs ("support weight" vs. "provide support")
  - Use measurable nouns - quantitative & unambiguous (e.g., weight, force, load, heat, light, radiation, current, flow, etc.

Defining Functions

WORK FUNCTIONS

VERBS			*NOUNS*	
			Measurable	***Non-Measurable***
Amplify	Attract	Change	Current	Circuit
Collect	Conduct	Control	Energy	Component
Emit	Enclose	Filter	Flow	Damage
Hold	Impede	Induce	Heat	Device
Insulate	Interrupt	Modulate	Load	Part
Prevent	Protect	Reflect	Torque	Repair
Repel	Shield	Transmit	Weight	Table

SELL FUNCTIONS

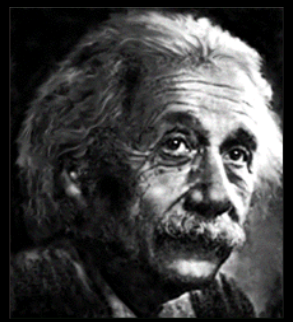
VERBS	*NOUNS*	
Create	Appearance	Beauty
Decrease	Color	Convenience
Enhance	Cost	Effect
Establish	Features	Finish
Improve	Form	Prestige
Increase	Style	Symmetry
	Texture	

Analyze with Function Cost Matrix

Components \ Functions	Cost (in cents)	Remove Marks		Secure Eraser		Improve Appearnace		Make Marks		Transmit Force		Accommodate Grip		Display Information		Support Lead		Protect Wood	
		%	¢	%	¢	%	¢	%	¢	%	¢	%	¢	%	¢	%	¢	%	¢
Eraser	.43	100	.43																
Metal Band	.25			50	.13	25	.06			25	.06								
Lead	1.20							80	.96	20	.24								
Body	.94					10	.09			40	.37	5	.05	5	.05	40	.36		
Paint	.10					50	.05											50	.05
Total	2.92	15	.43	4	.13	6	.20	29	.96	27	.67	2	.05	2	.05	13	.38	2	.05

Simplify Concept Design

"The best design is
the simplest one that works."



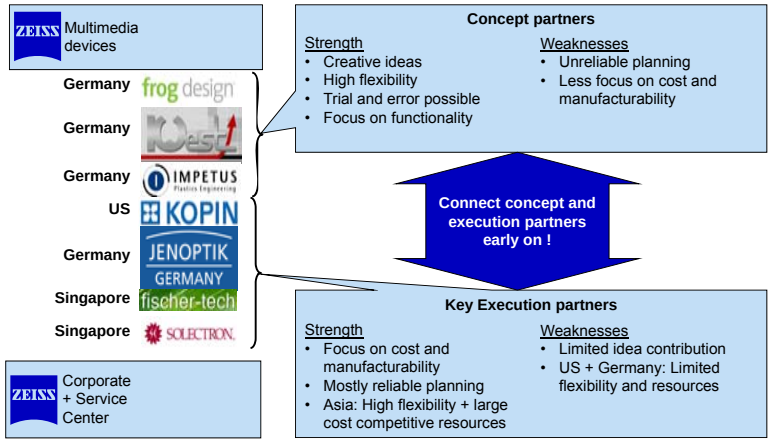
Albert Einstein

Competition or Partnership with Suppliers

Competition
- Believe there are more savings through competition
- Competition based on specifications or preliminary drawings
- Specs not oriented to supplier's/subcontractor's capabilities or product to maximize competition

Partnership
- Believe there is more savings through an effective partnership
- Brought in earlier in the process
- More effective cooperation to achieve requirements
- Specs oriented to supplier's/subcontractor's capabilities or product

Example Cinemizer©
Networked product development in complex partner landscape



Achieving Design To Cost

The first step is culture change with development personnel
- Change from a primary focus on schedule and performance
- Change to a balanced focus on performance, cost, and time to profit
- Management has to communicate and reinforce this message

Back up

Ten Steps to DTC

10. Track target cost achievement
9. Improve the production process
8. Consider the supply chain & involve suppliers
7. Simplify the design & apply DFM/A and DFT
6. Use cost models to support decision-making
5. Consider alternatives, trade-offs & optimization
4. Identify improvement areas with QFD, VA & Pareto
3. Establish & allocate cost targets
2. Balance target price with customer needs & specifications
1. Orient the company culture to value & profit management

Topic III: High leverage of external partners necessary to enter new business arenas

Carl Zeiss with tremendous pool of competences even in areas outside its core business
- **Zeiss also with consumer electronics and mass production experiences**
- **A mixed team of externally hired and internally staffed export is the optimum**

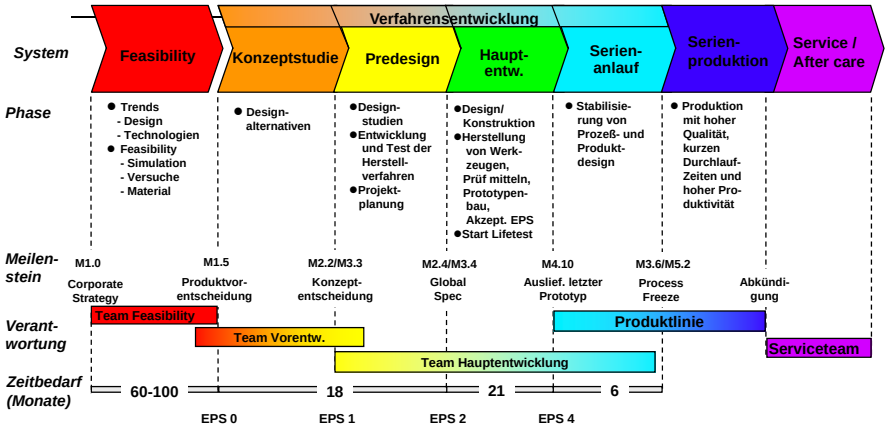
Clear benefits of external partners
- **Risk sharing and low asset base**
- **Faster learning curve for Zeiss**
- **Global networking enables combined leveraging of cost and expertise advantages**

Interface management to external partners consumes a lot of energy and effort
- **Global network difficult to align, especially if the project cannot be fully modularized**
- **For areas new to Zeiss it is still the best way to in-source market and product expertise**

Be realistic about your expectations and the role of the external partner
- **Clearly separate concept and execution partners in R&D**
- **Have in-house expertise to understand and manage the partner's contribution**

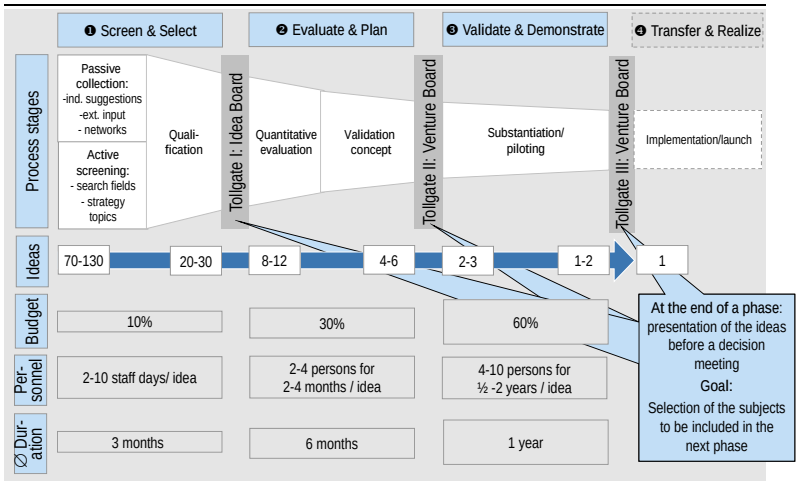
Cinemizer would not be a product by now without the significant external leverage

Product Generation Process Overview



The New Business Generation Process

Process stages, number of ideas, required resources

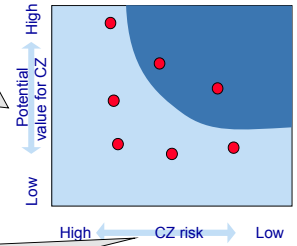


Criteria for the definition and selection of search fields are grouped according to trends and risks

Topic profiles consist of four core elements

1. **Title and general description of topic (What is the idea about?)**

2. **Potential value for Carl Zeiss**
   (Why does the field offer future-oriented options for CZ and do we really have to deal with these now?)
   - What current trends support the field?
   - Where is there potential for what disruptive innovations?
   - What new applications with high attractiveness for the customer are offered by the field?
   - What major CZ contribution to the field is conceivable?



3. **Opportunities/risks for Carl Zeiss**
   (How great is the possibility of Carl Zeiss entering the field?)
   - How "dangerous" is the competitive landscape? (companies which are already active in the field today are potential competitors, partners, customers)
   - How quickly can we and must we enter the field? (probable time scales for the materialization of business options)
   - What assets does CZ have in the field today? (CZ status)
   - Do initial, plausible business ideas exist?

4. **Important potential sources of information (existing contacts, known experts)**

Qualified ideas are prioritized in a portfolio with the aid of a scoring model

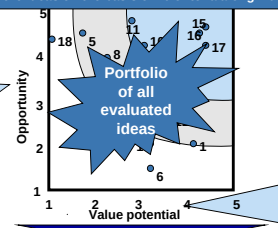
Stage 1: Answering core questions for the characterization of the business ideas

- Why does the world need this idea?
- Who will buy how much?
- How can the business be set up?
- How can money be earned with it?
- What are the most important steps in the implementation?
- What already exists?

Stage 2: Relative evaluation of the ideas on the basis of 10 criteria along 2 dimensions through scoring

Weighted scoring factors

6. Approximate time to market
7. Magnitude of required investments
8. Possible obstacles hindering technical feasibility
9. Possible obstacles for successful market entry
10. Quality and quantity of external and internal interest in the idea



Weighted scoring factors

1. Approximate current size of the addressable market
2. Approximate growth of the addressable market
3. Attractiveness of the idea for customers and users
4. Uniqueness and sustainability of the Carl Zeiss contribution
5. Potential for opening up other related markets in the long term

Idea Board discusses and makes decision on the next phase of the ideas

Initial evaluation of the ideas is performed on a comparative basis and is based on pragmatic, qualitative criteria

Traditional Cost Management	Target Costing / Design to Cost
• No real cost or price planning	• Market & competition drive price planning
• Costs determine price	• "Price to win" or target price determines costs
• Waste, inefficiency & supplier costs are the focus of cost reduction efforts	• Cost reduction is achieved by simultaneous product / process design
• Cost reduction is reactive; occurs after the fact	• Customer input guides requirements & cost planning
• Little visibility of costs; lack of cost data and cost estimating tools	• Structured cost data & estimating tools allow early feedback on design costs
• Cost accounting & manufacturing responsible for cost	• Cross-functional teams manage costs
• Suppliers involved after product designed	• Suppliers involved in concept and design of product

Target Costing & DTC Goals

Target Costing

Maximize the value proposition of a product to the customer in the defined market segment at the defined price point

and

Maximize the program profit to the developer

Design to Cost

Jointly achieve the target cost or design to cost goal and the defined product requirements

Achieving Design To Cost

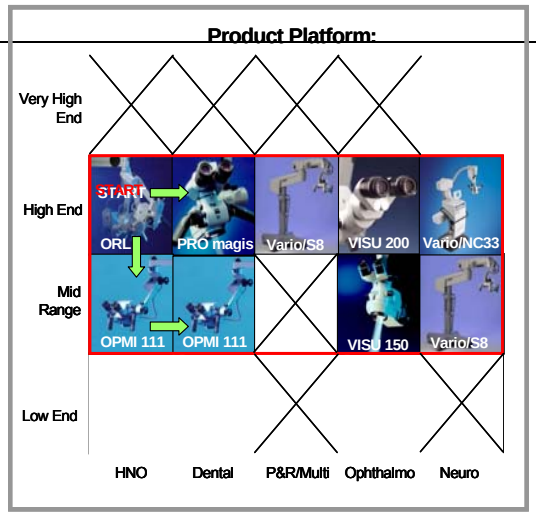
Three fundamental actions:

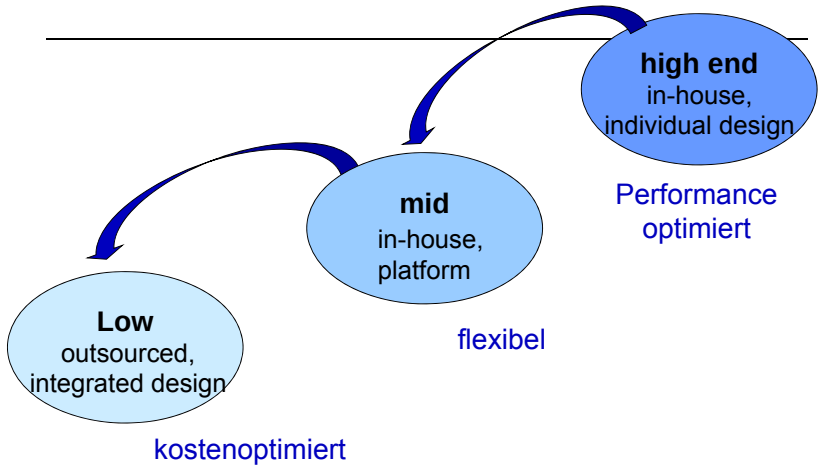
- Analysis of Alternatives **– development and analysis of architectural, concept and design alternatives**
- Trade-offs **– consideration of architectural, concept and design alternatives that will result in trading off capability to meet customer needs in one area to improve capability to meet customer needs in another area, e.g., reduced performance for reduced cost**
- Design Optimization **– refinement of design to drive down cost or improve performance or capability**

Definition Platform

A product platform is a **set of subsystems** and **interfaces** that form a common structure from which a **stream of derivative products** can be efficiently developed and produced.

(The Power of Product Platforms, Marc H. Meyer, Alvin P. Lehned)





Tollgate III criteria similar to Tollgate II, but with higher quality

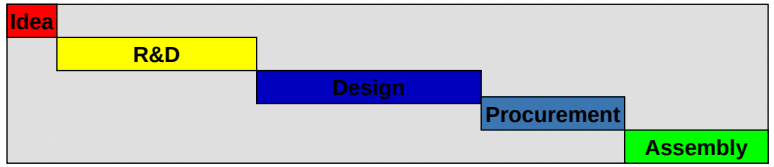
	Criterion	Fulfill-ment	Comment
Busines model	Technical proof of principle provided	○	
	USP identified for CZ	○	
	USP is sustainable	○	
	Positive feedback of lead customers	○	
	Approval by necessary partners	○	
	Availability of critical sourcing components	○	
Mentor	Suitable CZ SBU approves acceptance	○	
Updated business case	Initial sales in 2 years from Tollgate III	○	
	CZ sales potential > €50 million	○	
	Target EBIT margin > 5%	○	
	12-year DCF > 0	○	
Team	Core team ready for transfer	○	
Spec. additional criteria	e.g.: Value added concept	○	
	e.g.: Open technical questions	○	

Alternative decisions for the setup of a business at Carl Zeiss with inade-quate fulfillment of criteria:

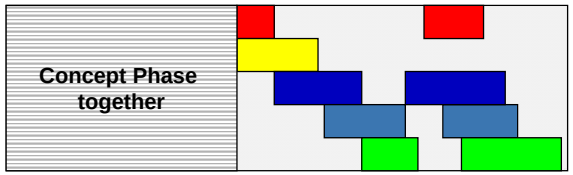
1) Reworking of project
2) Order to market idea externally
3) Discontinuation of all activities

How to Reduce the Time to Market ?

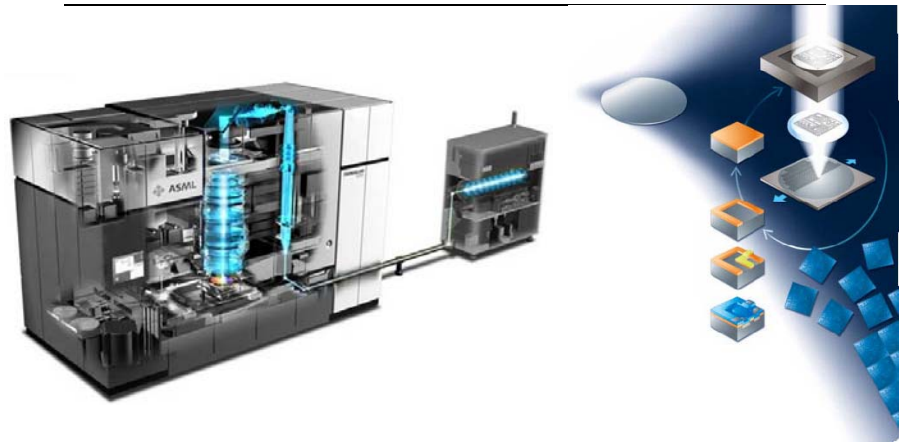
Previously sequential processes



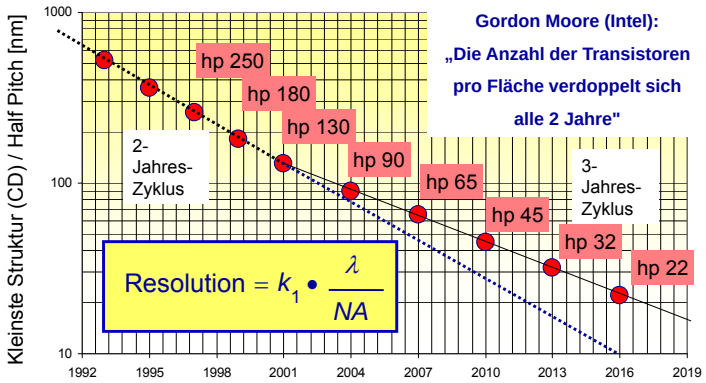
Today „Synchronous Develoment“



Lithography Optics by Carl Zeiss



Roadmap of Semiconductor Industry



Process Roadmap