The Art Of Innovation; How to bypass countless hurdles?

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Abstract
Mature companies grow often via consolidation and incremental innovation. They have so much focus on their running business that there is little room for significant innovations. However, for long-term business, companies need solutions beyond the ordinary. In this presentation we look at practical hurdles of significant innovations in several case studies. We analyze some aspects further, e.g. innovation models, roles in innovation, the market, and funding.

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TAOlkongsbergHistory

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Why Innovation and Solutions beyond the Ordinary?

Why is *Innovation* such popular *buzzword*?

Sales *price erosion* -> *low margin*

*Innovation maintains* sales *price* and *margin*

*Why “Solutions beyond the Ordinary”?*

*Mature companies* grow via consolidation and *incremental innovation*

*Mature companies* struggle to *innovate significantly*; creating *Solutions beyond the Ordinary* is rather difficult for them

What happens when current markets get saturated and current *solutions* get *obsolete*?

How can we fill the *market-product-technology pipeline* for the *next 30 years*?
Margin Problem Due to Price Erosion

- **First on market**
- **Competition**
- **Cost price**
- **Sales price**
- **Margin**

**Globalization and high pace increase sales price erosion**

High labor cost countries (Norway, Netherlands) lose the margin game

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Innovation is the Escape

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Market Product Life Cycle

- Infancy
- Adolescence
- Maturity
- Aging

- sales volume
- time
- decline
- growth
- stable
- taking shape
Where is Kongsberg Industry?

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Performance = \( f(\text{power, weight, } v_{\text{max}}, \text{fuel consumption, price}) \)

[Orbela 2008] Carlos Gorbea, Ernst Fricke, and Udo Lindemann,
_The Design of Future Cars in a New Age of Architectural Competition_,

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What is Innovation?

We apply the term **innovation** when something **new** (technology, design, application, or market) results in **better** **business** (or government) **performance**.
How, that is the Question

innovation

The vision and harsh reality

RIP
D. Idea
RIP
E. Idea
RIP
F. Idea
innovation
RIP
A. Idea
RIP
B. Idea
RIP
C. Idea
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Examples of Significant Innovations

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The Beginning of MRI scanners

1980
1982
1984
1986
1988

1. research proto
2. development 0.15T
3. regular 0.5T
4. special 0.5T
5. special 1.5T
6. volume 0.5T system

~2003
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From Research to Development

from one physics laboratory to multiple clinical hospitals

separate building, organization, process?

special 0.5T
regular 0.05T
research 4T
volume

10 developers
reproducible
maintainable software
clinical user interface: automatic settings
system verification and qualification
hospital site preparation

1988 ~ 2003

4 scientists
“system” = sum of boxes + research SW
all settings “manual”
technology development proceeds rapidly; serve luminary hospitals with specials

100
special 0.5T
regular .05T
research 4T
volume 0.5T system
special 1.5T
development ...

from quickies to structure
do anything to be fast in the market

research proto

1 2 3 4

everything grows, however, early processes do not scale

“colonel putsch”
ineffective development
caused by fragmentation

growth of development
growth of features
growth of manufacturing
→ need for regular processes

logistics by chasing

1 tiger teams
one babysitter per delivered system

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Existing Process Framework May not Fit

processes and procedures

facilitate

sales
supply chain, purchasing, logistics
manufacturing
installation, configuration, commissioning
maintenance
after sales

however, may constrain need and solution exploration
Various Innovation Approaches

DARPA, grand challenge

SFI, EU funding (precompetitive)

Skunkworks

Lockheed Martin -> KM

start-up

Teknologiparken Kongberg
Oslo Cancer Cluster
High Tech Campus Eindhoven

incubators

KTH Stockholm
Philips personal health

venture capitalists

open innovation
From Demonstrator to Product

from unconstrained coding to systems engineering

products per year

100

10

1


technical
own ideas
demonstrator
SW components

clinical
requirements
engineered
system

needs discovery
effort *4

1996

TECH EV RF
TECH EV CT/MR
TECH EV cardio
TECH EV RAD

predevelopment


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Adding other Applications

other clinical users, other images, new applications

products per year

100

10

1

predevelopment
EV RF
EV CT/MR
EV cardio
EV RAD
EGN
cine-mode
appl. model
X-ray projected images
static
print on film
slices and volumes
interaction, processing
dynamic
predevelopment
EV RF
EV CT/MR
EV cardio
EV RAD
EGN
cine-mode
appl. model
X-ray projected images
static
print on film
slices and volumes
interaction, processing
dynamic
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Best, the Netherlands workstation “own” and known SW

Hamburg, Germany part of acquisition system build on top of ...

predevelopment

Best, the Netherlands workstation “own” and known SW

Hamburg, Germany part of acquisition system build on top of ...

software re-used by other department in other location

products per year


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Re-use in New Unknown Market

Creating new business in new market

- Existing markets: known stakeholders, established contacts, understood applications
- New market: unknown stakeholders, no contacts, new applications


- Predevelopment
- EV RF
- EV CT/MR
- EV RAD
- EGN
- EV cardio
- appl. model

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Various Roles in Innovation

- Introduction
- MRI
- innovation models
- EasyVision
- roles, market
- Repli
- funding
- challenge

products per year

1980 1990 2000 2010

1 2 3 4 5 6 7 8 9 10

1 10 100

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Successful Innovation = Technological + Market

market innovations
- segments
- applications
- needs
- services

system

technological innovations
- materials
- circuits
- functions
- user interface

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System Architect links technology and market

market innovations
- segments
- needs
- services

applications

needs

applications

market innovations

systems architect

engineers

inventors

system

technological innovations
- materials
- circuits
- functions
- user interface

marketeers
Conservative SEs and PLs

- **systems engineering responsibilities**
  - performance
  - dependability

- **project leader responsibilities**
  - time
  - budget

- risk management
- **risk avoiding attitude**
  - solution beyond the ordinary
  - creative attitude
**Marketing <> Sales!**

<table>
<thead>
<tr>
<th>marketing</th>
<th>sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>understands and sees many (potential) customers</td>
<td>sells what is available</td>
</tr>
<tr>
<td>smells (latent) needs</td>
<td>convinces customers</td>
</tr>
<tr>
<td>transforms them in business</td>
<td>poor sales people only</td>
</tr>
<tr>
<td>creates the future</td>
<td>demand more from D&amp;E</td>
</tr>
<tr>
<td></td>
<td>determines today’s business</td>
</tr>
</tbody>
</table>

**Requirements discovery: Market-as-Laboratory**

**extreme: test Internet responses**
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The Tragedy of a Technology Start-up

100

paced milestones

10

1

2004 2006 2008 2010
predevelopment

R&D model

research  predevelopment


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From research to RD model

from flexibility for experts to production workhorse

paced milestones

2004 2006 2008 2010

R&D model

technology feasibility manual wafer handling performance, robustness automated process supplier


research predevelopment
Despite exceeding good performance no funding hit by the financial crisis

Paced milestones

Meeting milestones
Managing multinational building staff

Application development
Prepare ramp-up
Prepare field deployment
Money intensive

Research
Predevelopment
How to get the Money?

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Who is willing and able to invest the valley of death?
Summary of Experiences

1: from 1 to many
2: rapid technology
3: scaling
4: major change
5: from proto to product
6: new applications, new users
7: re-use by others
8: new market
9: technology development
10: valley of death

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Lessons Learned

R&D

Research: *inspire* rather than *constrain*

Predevelopment: *when* start *including* process *constraints*?

Early development and deployment: *requirement discovery* (market-as-laboratory)

Development and engineering: how to *scale* in all directions?

management

How to *foster long term* under short term pressure

How to survive the *valley of death*?

*Pacing* as early phase progress method
Challenge

How do we prepare Kongsberg/Norway successes for the next 30 years?

Who will take all hurdles and create tomorrow’s solutions beyond the ordinary?