How to manage projects & innovations

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Based on a lecture by Leonard Badet

Menu

Short introduction to industrial project management in 6 chapters

Cost management

Cost management
Orders of magnitude for development costs

- PMI IQOS cigarette: **$3 billion**
- New medicine: **$2.5 billion** (over 10 years development, out-of-pocket cost of $1.4 billion and time cost of $1.1 billion)
- New VW Golf generation: **$1.2 billion** (Sell 900k units annually, 6 years per generation, about $250/unit)
- BMW new 7 series: **$800 mio** (Sell 50k units per year, 7 years per generation, about $2'300/unit)
- Apple Newton: **$500 mio** (sold 300k units in total or $1700/unit (sold $1000 each…)
- iPhone 1: **$150 mio** (discontinued in July 2008, sold 6 mio units, about $25/unit)
- Dyson Supersonic hairdryer: **$71 mio**
- Sony's Gran Turismo video game: **$60 mio**
- BOBST quality control system: **3 mio CHF**, about 10 000 CHF/unit
- BOBST new sensor: **1 mio CHF**, about 500 CHF/unit
- BOBST new electronic board: **0.1 mio CHF,** about 100 CHF/unit

Cost management
Difficult exercise during the project

- A third of all projects were successfully completed on time and on budget over the past year
  Standish Group
- According to IBM study, only 40% of projects meet schedule, budget and quality goals
  Harvard Business Review 2004
- Average large IT project runs 45% over budget, 7% over time, and delivers 56% less value than expected
  Project Management Institute: Pulse of the Profession 2015
- One in six IT projects have an average cost overrun of 200%
  Harvard Business Review 2004

Cost management
Most frequent pitfalls with cost and time estimations

- **Lacked** clear **definition of scope**, deliverables and product specification
- **Lacked** proper **change management** during project (scope creep)
- **Erroneous** project **planning**
- **Accepted** to start project knowing that allocated time-to-market or budget was too tight
- **Underestimated** impact of resource **multitasking and time for project synchronization** (status meetings, schedule updates, project-related emails, brainstorming, …)
- **Poor risk management**, e.g., underestimate task difficulty or number of iterations
- Other project **uncertainties not captured** and addressed in risk analysis
- **Unplanned interferences** with other projects, change of project priorities
- **Resources not available** as planned (sickness, resignations, …)
- **Delays** induced by **internal / external suppliers**

Cost management
Additional human factors impacting cost and time estimations

Extra safety buffers are introduced in planning…

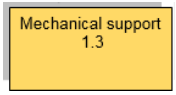
- Extra padding (= comfort buffers) in task duration given by resources
- Additional padding added by project manager

…and later wasted!

- Student syndrome – Resource fully applies itself to task at last possible moment before deadline (“I have time since I put a buffer”)
- Parkinson’s law – “Work expands so as to fill the time available for its completion” (e.g. perfectionism, unnecessary features added)
- Dependencies between tasks: delays are passed to next activities, but early finish are not

Cost management
Estimation activites

- For each work package, estimated effort in hours and cash-out. Example with case study for one work package
- As project progresses, cost estimation becomes more precise
  - i. Project Scope Statement is preliminary: +/- 50%
  - ii. When requirements are well defined: +/- 25%
  - iii. When detailed specifications are approved: +/- 10%



WP 1.3 Mechanical support ACTIVITY	MOYEN 50%	OPTIMISTE 20%	PESSIMISTE 80%	(4+1+1)/6	Cash-out
P3 sous-total P2					
Lighting module					
• Définir forme et composants mécanique Lighting Module	6	4	12	7	
• vérifier aspects dilatation thermique	6	4	12	7	
Miroirs & Vitre					
• Calculer la forme et les tolérances pour les miroirs	80	80	80	80	
• Définir fixation miroir	8	8	8	8	
• Rechercher fournisseurs injection & métallisation	16	4	32	17	
Thermal dissipation (air cooling)					
• Recherche partenaire et analyse concept global	12	8	24	13	
Définir forme du radiateur, débit wr circuit d'air après étude thermique du partenaire	12	8	24	13	
• Définir température de travail du radiateur	4	2	8	4	
• Choisir ventilateur et définir sa fixation	4	2	8	4	
• Design interface entre les deux PCBs et le radiateur	8	4	16	9	
Structure mécanique de base					
• Définir atructure mécanique de modules qui porte cartes, miroirs, glass, radiateurs	40	40	80	47	
• Réaliser étude pour miroirs	16	8	32	17	
• Réaliser étude pour refroidisseur	16	8	24	16	
• Créer dessins de détails	60	40	100	63	
P4 sous-total P4					
• Suivi fabrication pièces pour Lighting module	8	8	8	8	
• Suivi fabrication miroirs et vitre	8	8	8	8	CHF 10'000.00
• Suivi fabrication refroidisseurs	8	8	8	8	CHF 2'000.00
• Assemblage général	16	8	24	16	
• Corriger les dessins (structure, miroirs et vitre, refroidisseurs)	20	15	40	23	
P5 sous-total P5					
• Suivi fabrication et corriger pièces pour Lighting module	8	4	16	9	
• Au besoin correction miroirs et vitre	6	4	12	7	
• Suivi fabrication et correction refroidisseurs	6	4	12	7	
• Assembler le tout	24	8	32	23	CHF 3'000.00
• Corriger les dessins (structure qui tient le tout, miroirs et vitre, refroidisseurs)	20	15	40	23	
Suivi première serie	20	15	40	23	
Documentation & introduire dans SAP	24	16	40	25	
Total	456	333	740	483	**CHF 15'000.00**

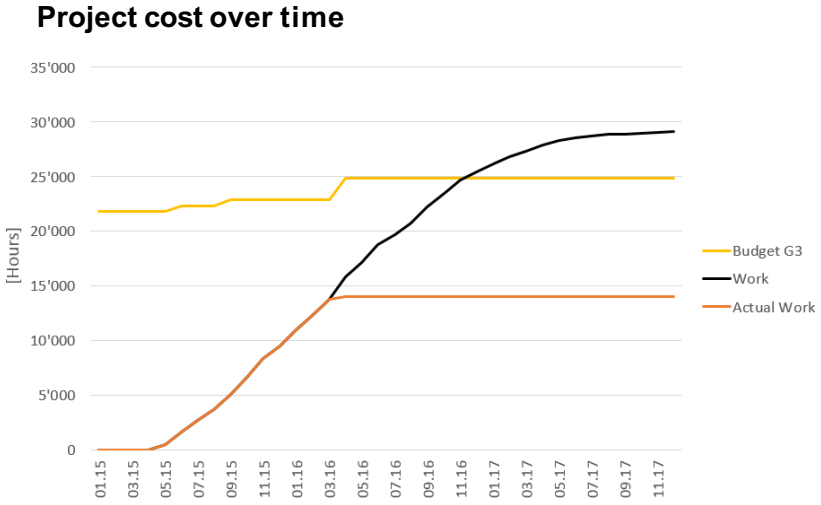
Cost management
Project costs estimation

Aggregate cost of all work packages, without forgetting

- **Project management cost**, including time for meetings (e.g. 8-15 % of total effort)
- **Material cost** (e.g. new test equipment)
- **Travel cost** (e.g. to visit suppliers and first customers, visit trade fairs)
- **Supplier cost for outsourced work packages**, estimated based on budgetary or firm quotations
- **Fixture costs** (e.g. necessary during product production and testing)
- **Cost for prototypes and pre-series** (sold with lower margin)
- **Warranty cost**

Cost management
Project cost control

- Cost control means comparing budgeted costs with actual costs at different stages of project.
- Shall be done on regular basis, e.g. monthly.
- Cost followed with **S-curve** displaying cost (e.g. project hours) vs time



Cost management
Identify the right issue

"In a market with 20% annual growth and 12% price-drop per annum, technological products which arrive on the market six months late but on budget generate 33% less profit over five years, whereas **getting the product to market on time but 50% over budget only reduces profits by 4%“**

Study by Ali and al. in 1995

Cost management
Cost of time and time to market

- Companies often focus attention on project cost and neglect cost of time !
- Statistics indicate that following variations are equivalent in product development if one considers cumulated profit over product lifetime
  i. ± 50 % development cost
  ii. ± 10 % product cost
  iii. ± 4 % sales price
  iv. ± 3 months product introduction date
- Sensitivity analysis can be done to identify major drivers behind cumulated profit and to drive decisions during project (e.g. trade cost for time)

How to turn projects into business case

Project economics
Basic principles

- New products are launched to generate net profit margin for company
- Project financial viability must be demonstrated at project launch
- During project development company will only incur cost (cash outflows).
- After product launch company will have residual project cost, and revenues will be generated (cash inflows).
- After project closing company will incur only revenues
- When considering if investment shall be made in a project, company must consider the cost to borrow money, opportunity to reimburse debts, opportunity to invest, etc., so-called weighted average cost of capital (WACC)

Project economics
How do you demonstrate the business case

Project economics
Step 1: estimate overall project cost over time

- Consider main cost categories: R&D, SPL (single purchase limit), Marketing and Sales, Services (or warranty)
- Split costs between hours (salary) and cash-out, the impact for the company is not the same
- Split your cost over the project phases
- Add a risk reserve
- Create best/worst case using percentage

PROJECT COSTS

	Until Gate 7 (costs until G3 included)			Costs until Gate					
Activity	**Hours**	**kCHF**	**%**	**2016**		**2017**		**2018**	
R&D Mechanical		500	28%						
R&D Electrical		300	17%						
R&D Validation		100	6%						
R&D Pre-serial and Updates		30	2%						
R&D Project Management and Support		100	6%						
Subtotal R&D costs	**0**	**1030**	**57%**		**5%**		**40%**		**40**
SPL Industrialisation		150	8%						
SPL Project Management and Support		50	3%						
Subtotal SPL costs	**0**	**200**	**11%**		**5%**		**20%**		**60**
M/S Open House costs		50	3%						
M/S Tools, pictures, videos, brochures, advert.		50	3%						
M/S Boxes for open house, tests and demos		20	1%						
M/S Project Management and Support		30	2%						
Subtotal Marketing and Sales costs	**0**	**150**	**8%**						**50**
Services Field Interventions		100	6%						
Services Technician Training		20	1%						
Services Warranty		80	4%						
Services Project Management and Support		20	1%						
Subtotal Services costs	**0**	**220**	**12%**		**5%**		**0%**		**50**
Risk reserve	-	200	11%		**10%**		**20%**		**20**
Total costs Base case	**0**	**1800**	**100%**	**100**	**6%**	**499.5**	**28%**	**757**	**42**
Total costs Worst case	-	1980	110%	110	6%	549	28%	833	42
Total costs Best case	-	1620	90%	90	6%	450	28%	681	42

Template example

Project economics

Step 2: estimate margin obtained from selling the product

- Start bottom up
- Make distinction between COGS, COS and EUP
- Gross Margin (GM)

  represent the benefit you make when you sale a product
- End User Price (EUP) will impact your turnover

TARGET PRODUCTION COSTS

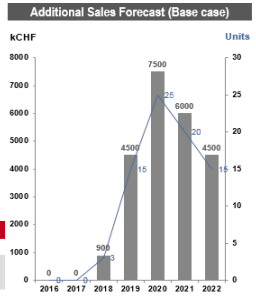
	kCHF	%
End User Price (EUP)	**300**	**100%**
Gross Margin	90	30%
Training / Instruction	5	2%
Others	5	2%
Cost of Sales (COS)	**200**	**67%**
Engineering / Specialty	25	8%
Transports / Insurance	10	3%
Installation	10	3%
Cost of Goods Sold (COGS)	**155**	**52%**
Packaging	5	2%
Machine Production Costs	150	50%
		0%

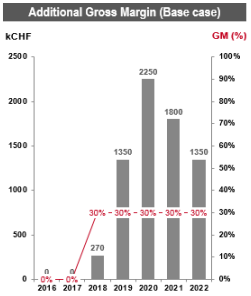
Template example

Project economics
Step 3: estimate sales forecast over time

- Estimates sales over the years from start to end of sales availability
- Consider a ramp-up and a phase-out
- Consider a best- and worst-case using percentage
- For large products portfolio, consider internal cannibalization resulting of your product launch

Template example





SALES FORECAST

Worst Case represents	80%
Best Case represents	120%

Additional Sales Forecast (Base Case)	EUP	GM/ Unit	Current Sales/Y	ADDITIONAL (DELTA Δ) SALES / YEAR 2016	2017	2018	2019	2020	2021
New product (no cannibalization)	300	90	0			3	15	25	20
Total Additional Sales Forecast (Units)	-	-		**0**	**0**	**3**	**15**	**25**	**20**
Total Additional TO	-	-		**0**	**0**	**900**	**4500**	**7500**	**6000**
Total Additional GM	-	-		**0**	**0**	**270**	**1350**	**2250**	**1800**
GM (%)	-	-		**0%**	**0%**	**30%**	**30%**	**30%**	**30%**
GM Worst Case	-	-		0	0	216	1080	1800	1440
GM Best Case	-	-		0	0	324	1620	2700	2160

Project economics

Step 4: Calculate project metrics: Net present value (NPV) and Payback time

- Use an automated tool (don't do the calculation by hand)
- Try different scenarios with optimistic and pessimistic evolution
- Challenge your assumptions, us common sense too
- Use standards metrics ROI (return on investment), Payback time, NPV or IRR (internal rate of return)

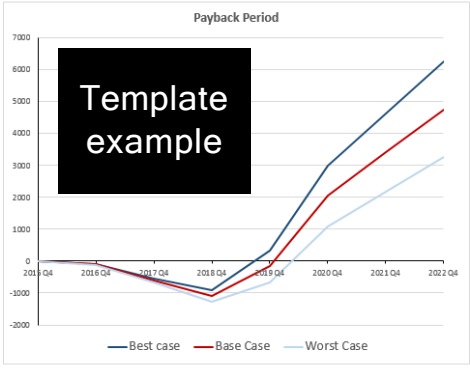
PROJECT PROFITABILITY

Gate 2	01.09.2016
Gate 3 estimated	01.12.2016
Gate 6 (start serial production)	01.09.2018
First Ex-Works machine	01.11.2018
Gate 7 (end project)	01.06.2019
WACC	10.00%

Payback date (base case)		**27.01.2020**
Project costs (base case)	kCHF	1800
Additional annual TO (base case)	kCHF	7500
Additional annual GM (base case)	kCHF	2250

Net Present Value (NPV) 5 years from Gate 3		
Worst	kCHF	1'098
Base	kCHF	1'893
Best	kCHF	2'689

Payback in years since Gate 3	
Worst	3.5
Base	3.2
Best	2.8



Project economics
Return on Investments (ROI)

- Measures the efficiency of an investments relative to the return
- Determined by dividing the investment return by the investment cost
- Easily calculated but omit the impact of time and the cost of the capital invested in the project
- The higher the better, a flat project gives a 100% ROI
- most common tool for investment decision

Exercise !

You invest 70 kCHF in development hours + 40 kCHF of cash-out to develop your product.

You expect to sell 4000 unit of your product at 120 chf with 35% of gross margin.

What is your ROI ?

$$ROI = \frac{R - C_0}{C_0} \cdot 100$$

$R = Total\ gain$
$C_0 = Total\ initial\ investement\ costs$

Project economics
Net Present Value (NPV)

- Measures the future cash flow of an investment, there
- It compares the present value of the cash outflows to the present value of cash inflows
- Considers the cost of the capital (as a discount rate), companies often use weighted average cost of capital (WACC) as discount rate
- Include the time
- Must be positive for profitable project

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

$R_t = Net\ cash\ flow\ during\ a\ period\ t$
$i = Discount\ rate$
$t = Number\ of\ timer\ periods$

Exercise !

You plan to invest 100 kCHF in a project that will generate a return of 30 kCHF over the next 5 years. Considering a cost of capital of 10%.

What is the NPV after 6 years ?

Project economics
NPV calculation

Year	Outflows	Inflows	Net flow	Discounted cash flow
0	-100 000 CHF	- CHF		
1	- CHF	30 000 CHF		
2				
3				
4				
5				

Project economics
NPV calculation

Year	Outflows	Inflows	Net flow	Discounted cash flow	Discounted cash flow calculation
0	-100 000 CHF	- CHF	-100 000 CHF	- 100 000 CHF	= -100 000/(1+0.1)^0
1	- CHF	30 000 CHF	30 000 CHF	27 273 CHF	= 30 000/(1+0.1)^1
2	- CHF	30 000 CHF	30 000 CHF	24 793 CHF	= 30 000/(1+0.1)^2
3	- CHF	30 000 CHF	30 000 CHF	22 539 CHF	= 30 000/(1+0.1)^3
4	- CHF	30 000 CHF	30 000 CHF	20 490 CHF	= 30 000/(1+0.1)^4
5	- CHF	30 000 CHF	30 000 CHF	18 628 CHF	= 30 000/(1+0.1)^5
	-100 000 CHF	**150 000 CHF**	**50 000 CHF**	**13 724 CHF**	

Project economics
Internal Rate of Return (IRR)

- Measures the future growth of an investment
- Calculated by setting the NPV to 0 and finding resulting IRR
- Cannot be calculated analytically
- The highest IRR is the better
- In theory, if the IRR is higher than the discount rate (or cost of capital), the project is profitable)

$$0 = NPV = \sum_{t=1}^{n} \frac{C_t}{(1 + IRR)^t} - C_0$$

$C_t = Net\ cash\ inflow\ during\ the\ period\ t$
$C_0 = Total\ initial\ investement\ costs$
$t = Number\ of\ timer\ periods$

How to use it

Calculate the NPV of your project, the modify the discount rate (cost of capital) until you reach a NPV = 0

For our previous example, the IRR is 15% so it's good to invest !

Project economics
Summary

ROI

$$ROI = \frac{R - C_0}{C_0} \cdot 100$$

$R = Total\ gain$
$C_0 = Total\ initial\ investement\ costs$

Total profitability

- Good for short terms investments
- Easily calculated

NPV

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

$R_t = Net\ cash\ flow\ during\ a\ period\ t$
$i = Discount\ rate$
$t = Number\ of\ timer\ periods$

Value

- Consider cost of the capital and time impact
- Calculated with a tool

IRR

$$0 = NPV = \sum_{t=1}^{n} \frac{C_t}{(1+IRR)^t} - C_0$$

$C_t = Net\ cash\ inflow\ during\ the\ period\ t$
$C_0 = Total\ initial\ investement\ costs$
$t = Number\ of\ timer\ periods$

Growth

- Consider cost of the capital and time impact
- Calculated with a tool

Risk management

Risk management
Introduction

From “No risk no fun”

To “Know risk know fun”

Risk management
Introduction

Risk is uncertain event that, if it occurs, has **positive or negative effect** on at least one project objective such as **scope, time, cost or quality**

- Positive risks are opportunities
- Negative risks are threats

Projects always contain risks. **If you do not manage project risks, they will derail your projects**

- A risk can have one or several causes, and one or several impacts
- Art of project management is risk management. When done efficiently, risks can be reduced by over 80%

Risk management
Methodology

Risk identification

- Determine which risks might affect project; document risk characteristics

Qualitative risk analysis

- Prioritize risks for further analysis or action

Quantitative risk analysis – if worth it

- Numerically analyze effect of identified risks on overall project objectives

Risk response planning

- Develop options and actions to enhance opportunities and reduce threats

Risk monitoring and control

- Track identified risks, monitoring residual risks, identify new risks, execute risk response plans

Risk management Methodology

Main tool for risk analysis is **Risk Register**

BOBST

Project name:
Project number:
Project coordinator:
Date:

RISK REGISTER

INITIAL RISK ASSESSMENT - THREATS									
ID	Risk	Category	Sub-category	Initial probability	Initial impact	Initial value	Strategy	Owner	Risk response
1	E.g. specifications unclear	Technical	Requirements	8	8	64	Mitigate		Schedule regular meetings with customer
2	E.g. € decline, impacting target product margin	External	Market	8	4	32	Avoid		Find suppliers in € zone
3	E.g. new requirements added without additional budget	Project management	Planning	4	4	16	Mitigate		Limit acceptance of new requirements
4						0			

Risk management Methodology

Define rules for risk assessment

Categories	Sub-categories	Probability	Impact*	Threats response strategy	Opportunities response strategy
Technical	Requirements, technology, complexity, interfaces, performance, reliability, availability, quality	8 = very high	8 = very high	Avoid	Exploit
External	Sub-contractors, suppliers, regulatory, market, customer	4 = high	4 = high	Transfer	Enhance
Organizational	Project dependencies, ressources, funding, prioritization	2 = moderate	2 = moderate	Mitigate	Share
Project management	Estimating, planning, controlling, communication	1 = low	1 = low	Accept	Accept

*** Definition of impact scale**

	Low (1)	Moderate (2)	High (4)	Very high (8)
COST	< 10% increase	10-20% increase	20-40% increase	> 40% increase
TIME	< 5% increase	5-10% increase	10-20% increase	> 20% increase
SCOPE	Minor areas of scope affected	Major areas of scope affected	Scope reduction unacceptable to sponsor	Project end item is effectively useless
QUALITY	Only very demanding applications affected	Quality reduction requires sponsor approval	Quality reduction unacceptable to sponsor	Project end item is effectively useless

Risk management Methodology

- Probability and **impact matrix for threats**
- Risks with highest probability and impact levels must receive focus

PROBABILITY

IMPACT	1	2	4	8
8	8	**16**	**32**	**64**
4	4	8	**16**	**32**
2	2	4	8	**16**
1	1	2	4	8

32 – 64: Risks require priority actions and aggressive risk response strategies

16: Risks require actions and risk response strategy. Implement risk response if risks move to above category or if time allows

1-8: Risks not critical, documented for periodic review

Risk management Methodology

Risk response strategies for threats

- **Avoid**
  Eliminate threat by eliminating cause (e.g. remove work package), isolate project objectives from impact, relax objectives, clarify requirements, improve communication, acquire know-how
- **Mitigate**
  Reduce probability or impact of threat, making it smaller risk. Reinforce test plan, choose more reliable supplier, build prototype
- **Transfer**
  Make another party responsible for risk, e.g. by outsourcing the work, purchasing insurance
- **Accept**
  Active acceptance involve creation of contingency plans and contingency reserves to be implemented if risk occurs. Passive acceptance leaves actions to be determined as needed, if (after) the risk occurs

Risk management
Methodology

- **Mitigate** Practice the route several times with rope and have top perfect mental and physical fitness
- **Accept** Have papers in order…

- **Avoid** Climb using proper equipment and training
- **Mitigate** Wear helmets
- **Transfer** Subscribe to accident & life insurance

Risk management
Methodology

Risk response strategies for opportunities

- **Exploit**

  Exploit opportunity, e.g. add work or change project scope to make sure that opportunity occurs, use better resources, improve quality, add functionality

- **Enhance**

  Increase likelihood (probability) and / or positive impacts of risk event

- **Share**

  Allocate ownership of opportunity to third party that is best able to achieve the opportunity

- **Accept**

  Do not implement any action

Risk management
Methodology

Example with use case:

New Quality Control product could also be sold in an industry other than packaging

- **Exploit** Enhance project scope and product specifications to encompass requirements of both industries, decide to also sell product in 2nd industry
- **Enhance** Perform minor adjustments to product specifications to better serve 2nd industry but without changing project scope, publish product article in specialized magazine of that other industry to probe interest
- **Share** Form partnership or joint venture with player in that other industry, offer licenses to best players in that industry
- **Accept** Focus only on packaging market

Risk management
Methodology

Example of Risk Register for case study, filled out with extended project team

INITIAL RISK ASSESSMENT - THREATS									
ID	Risk	Category	Sub-category	Initial probability	Initial impact	Initial value	Strategy	Owner	Risk response
12	Jitter and jam due to data quantity	Technical	Performance	4	8	32	Mitigate	R&D QC	Perform test on prototype ASAP
29	Precision of detection of vertical embossing	Technical	Performance	4	8	32	Mitigate	S&A	Perform customer trials (with broad range of samples)
34	Technology of industrialisation	Technical	Complexity	4	8	32	Mitigate	Indus CORES	Try asembly setup, and/or investigate alternative solutions
23	Ending up with a complex HMI	External	Customer	3	8	24	Mitigate	S&A	Involve S&A and field service techs from the start
32	Not reaching product introduction targets	Project management	Ressources	4	4	16	Mitigate	Mgmt	Filter requests for current product evolutions
2	Processing time	Technical	Availability	8	2	16	Mitigate	Indus CORES	Buy from well known seller
7	Inability to synchronize mechanical displacement of box with image acquisition	Technical	Requirements	4	4	16	Mitigate	S&A	Tests on PCR machine with camera
15	Insufficient processing power for framerate	Technical	Performance	2	8	16	Mitigate	R&D QC	Perform test on prototype ASAP
17	Accuracy and repetitivity on low contrast mark with noisy substrate	Technical	Performance	4	4	16	Mitigate	R&D QC	Perform test on prototype ASAP
25	Perturbation caused by dust	External	Reliability	2	8	16	Mitigate	Indus CORES	Today's solutions are acceptable; analyse and if necessary improve current solutions
1	€ decline, impacting of Fx on product and project cost	External	Market	2	4	8	Accept	Indus CORES	Find suppliers in € zone
3	Llife time of processing unit	Technical	Reliability	4	2	8	Accept	S&A	Mitigation solution exists
4	Artefacts due to rotation between cameras	Technical	Quality	2	4	8	Accept	R&D QC	

Risk management
Methodology

Quantitative risk analysis: numerically analyze effect of identified risks on overall project objectives

1. Determine which risk events warrant a response
2. Determine overall project risk
3. Determine cost and schedule reserves

Expected Monetary Value (EMV) provides overall ranking of risks

EMV = Probability $\times$ Impact

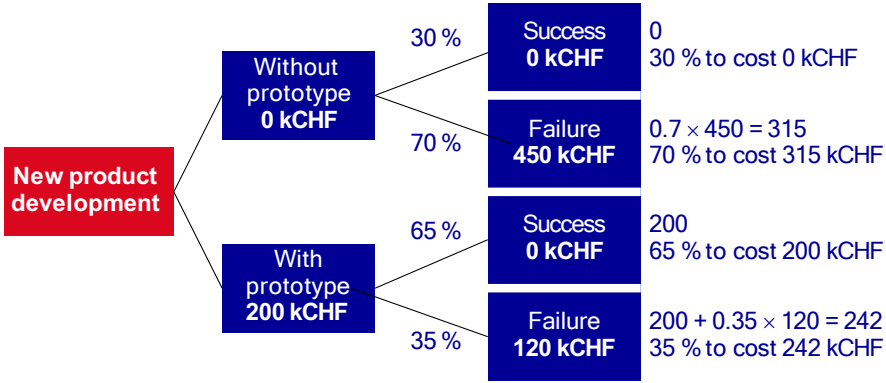
Risk management
Quantitative risk analysis exercise

- You develop a **new product**
- **Without** building a **prototype** you estimate a **70% risk to fail** to meet quality requirements and a resulting cost impact of **450 kCHF** (rework and scrapping costs)
- **With** building a **prototype** that will cost you **200 kCHF** you estimate a **35% risk** to fail to meet quality requirements for the non-tested part and a resulting cost impact of **120 kCHF**

What do you do and how do you justify your choice ?

Risk management
Methodology

Build a prototype !



Risk management Methodology

Risk response planning: implement actions to reduce risk level and risk mitigation reserves

- **Residual risks**
  - Risks that remain after risk response planning (e.g. accepted risks)
  - Residual risks should be documented and monitored
- **Contingency reserves**
  - Determine amount of contingency time and cost reserves needed to cover **identified risks**. E.g. the project requires 2 months' time and $120’000 to accommodate the known risks on the project
  - Contingency reserves are included in cost baseline
- **Management reserves**
  - Account for **unknowns**; items you could not identify in risk management
  - Management reserves are estimated top-down (e.g. 5% of project cost)

Risk management
Methodology

Risk management is a **key activity** in project management

- Risk management should be performed on every medium or large size project
- Risk Register template makes it easy to implement and track risk management
- Advice: **Do a risk review every week, during your project follow-up meeting and with the core team !**