Project Risk Analysis & Management

- Field & Keller 109-122, 222-223
- Moder, Phillips, Davies 305-311
- Yeates 43-45
- Shtub, Bard, Globerson 130-136
- Vose D. “Quantitative risk analysis: a guide to Monte Carlo simulation modelling”
- Grey S. “Practical risk assessment for project management”
- Chapman C., Ward S. “Project risk management: processes, techniques & insights”

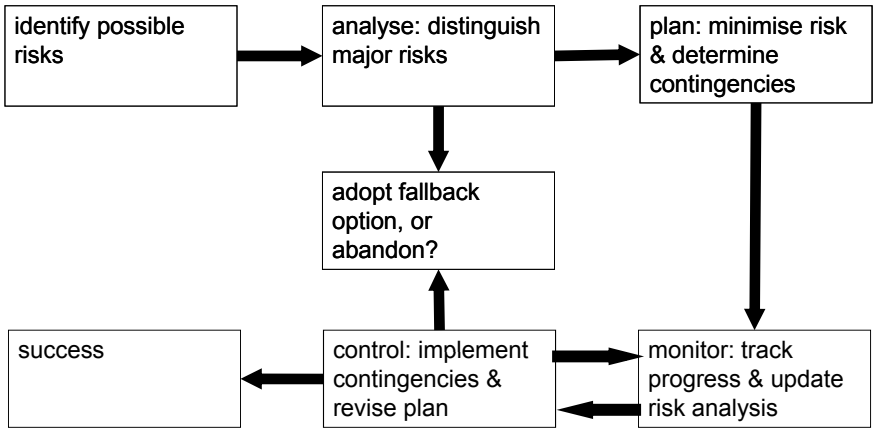
Sopwith Aircruiser 3

- is the project viable?
- are the risks acceptable; can they be reduced?
- compare the radical proposal SAC 3a and the incremental SAC 3b
- qualitative risk analysis, using the experience of similar developments, e.g. Airbus A380
- quantitative risk analysis using the SAC database

Summary

- role of project risk analysis
- qualitative analysis
  - multi-dimensional
  - rigour & justification
- Monte Carlo simulation & financial risk analysis
- Monte Carlo simulation & schedule risk analysis

The risk management process



Role of risk analysis

- at planning stage: to decide whether to proceed
- or help produce a better plan
- trade-off risk vs. cost or duration?
- during the implementation: provides a discipline for reviewing risks
- and identifies impact of new data
- provides “early warning”: deal with potential problems earlier, more cheaply & more effective

Qualitative vs. quantitative risk analysis

- qualitative, e.g. risk assessment matrix:
  - structured checklist noting uncertainties & impacts
  - flexible
  - accessible
  - quick & cheap
  - a useful first stage, identifying possible risks
- quantitative:
  - obtain numerical estimates
  - build computer models of impacts
  - more rigorous
  - better decision making
  - but requires time & money

Possible sources of risk

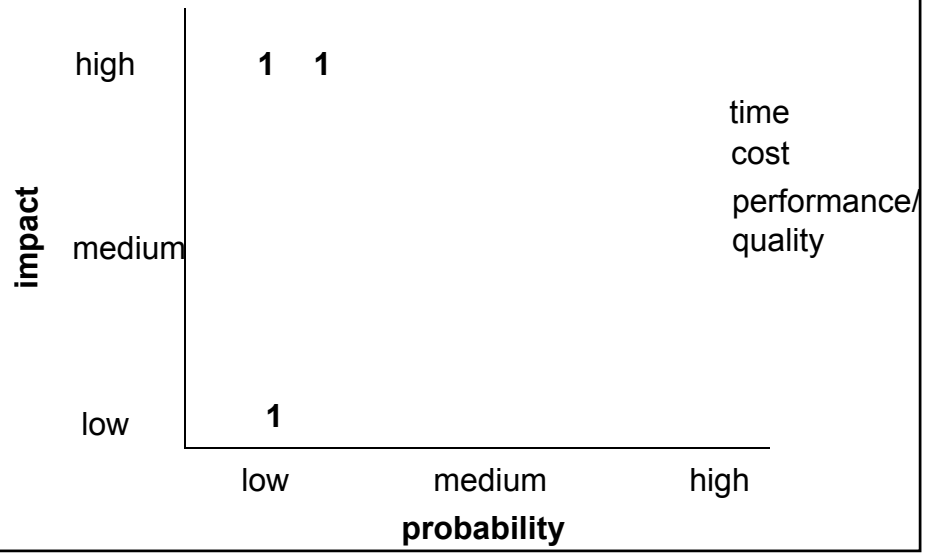
a generic checklist relevant for qualitative & quantitative analyses

- environment
  - government policy, exchange rates, availability of skilled labour, weather
- specification
  - ambiguous, changing
- technical
  - new methods, technologies, materials
- resources
  - staff, hardware/ equipment, materials
- integration
  - software modules, new & old systems
- management
  - sub-contracts, multiple parties experience, project management capability
- other sources: danger of checklists?

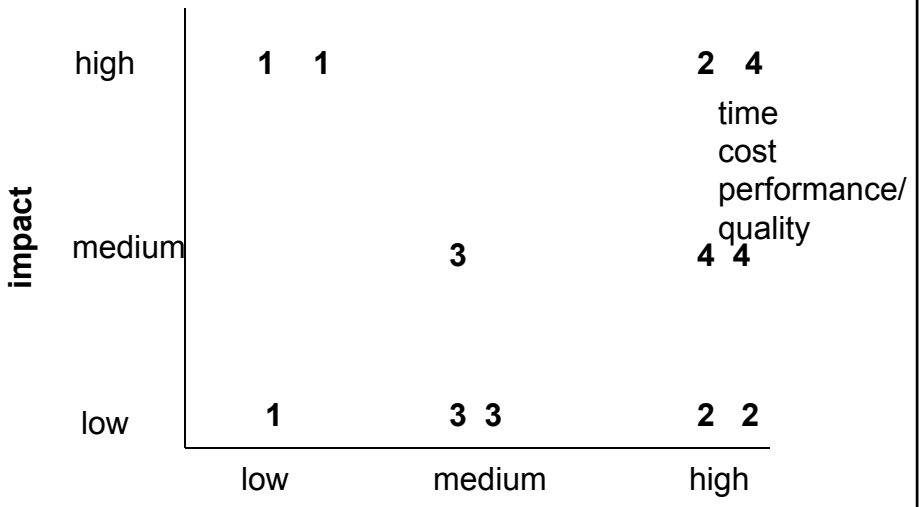
A qualitative approach

- relate generic checklist to particular project
- e.g. risk (1) = availability of suitable hardware (a “resource”)
- event = not available on time
- probability = “low”
- impact on several dimensions:
  - time = high
  - cost = high
  - technical capability/ performance = low
- technical capability/ performance may have sub-categories e.g.:
  - capacity
  - speed
  - reliability
- justify probability and impact estimates
  - interview reports with experts
  - evidence from similar projects (appropriate context)

A multi-dimensional risk assessment matrix



Plotting further risks



1. availability of hardware
2. staff recruitment
3. sub-contracted software
4. integration with existing data base

Quantitative risk analysis

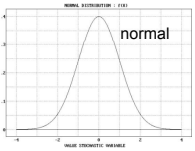
- qualitative analysis identifies potential risks
- qualitative risk analysis may be sufficient for some projects
- other projects and specific risks may justify quantitative analysis
  - availability and cost of data collection
  - value in decision making
- PERT analysis: misleading but still included in some textbooks
- Monte Carlo simulation
- financial risk , e.g. X400 and a reminder from Quantitative Management Techniques
- project network schedule risk

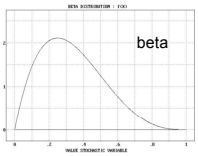
Basic financial model (impact on cost)

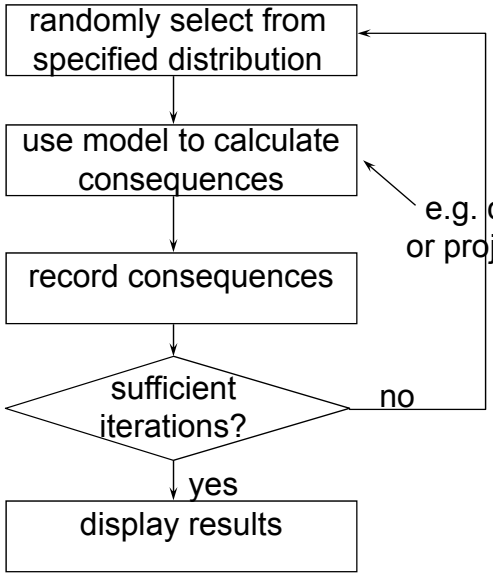
DEVELOPMENT OF THE X400												
sales p.a.	24000											
price (£)	18000											
operating fixed costs p.a. (M£)	80											
marginal cost per car (£)	6200											
discount rate (p.a.)	20%											
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Capital investment (M£)												
design new car	30	50	30									
design production line		10	30	30								
build production line			50	150	100							
establish marketing/distribution			10	10	30							
	30	60	120	190	130	0	0	0	0	0	0	0
Operating costs (M£)												
fixed costs p.a.						80	80	80	80	80	80	80
variable production						149	149	149	149	149	149	149
	0	0	0	0	0	229	229	229	229	229	229	229
Total costs (M£)	30	60	120	190	130	229	229	229	229	229	229	229
Income (M£)												
sales						432	432	432	432	432	432	432
total					0	432	432	432	432	432	432	432
Profit (M£)	-30	-60	-120	-190	-130	203	203	203	203	203	203	203
Cumulative profit (M£)	892											
NPV (M£)	14											

Monte Carlo simulation

e.g. normal, beta, uniform





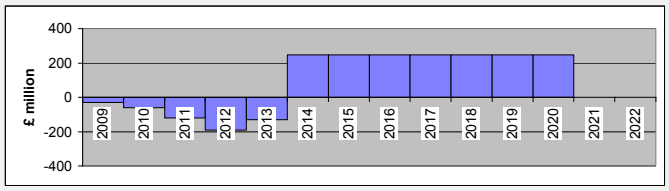


e.g. cost model or project network

Simulation iteration

DEVELOPMENT OF THE X400

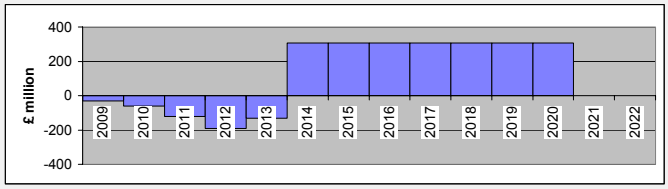
	mean	s.d.	sample									
sales p.a.	24000	4000	26587									
price (£)	18000	1000	19180									
operating fixed costs p.a. (M£)	80	5	78									
marginal cost per car (£)	6200	1000	6967									
discount rate (p.a.)	20%	0%	20%									
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Capital investment (M£)												
design new car	30	50	30									
design production line		10	30	30								
build production line			50	150	100							
establish marketing/distribution			10	10	30							
	30	60	120	190	130	0	0	0	0	0	0	0
Operating costs (M£)												
fixed costs p.a.						78	78	78	78	78	78	78
variable production						185	185	185	185	185	185	185
	0	0	0	0	0	263	263	263	263	263	263	263
Total costs (M£)	30	60	120	190	130	263	263	263	263	263	263	263
Income (M£)												
sales						510	510	510	510	510	510	510
total						510	510	510	510	510	510	510
Profit (M£)	-30	-60	-120	-190	-130	247	247	247	247	247	247	247
Cumulative profit (M£)	**1197**											
NPV (M£)	77											



Simulation iteration

DEVELOPMENT OF THE X400

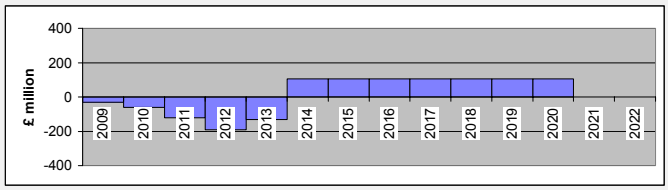
	mean	s.d.	sample									
sales p.a.	24000	4000	30228									
price (£)	18000	1000	18308									
operating fixed costs p.a. (M£)	80	5	79									
marginal cost per car (£)	6200	1000	5514									
discount rate (p.a.)	20%	0%	20%									
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Capital investment (M£)												
design new car	30	50	30									
design production line		10	30	30								
build production line			50	150	100							
establish marketing/distribution			10	10	30							
	30	60	120	190	130	0	0	0	0	0	0	0
Operating costs (M£)												
fixed costs p.a.						79	79	79	79	79	79	79
variable production						167	167	167	167	167	167	167
	0	0	0	0	0	246	246	246	246	246	246	246
Total costs (M£)	30	60	120	190	130	246	246	246	246	246	246	246
Income (M£)												
sales						553	553	553	553	553	553	553
total						553	553	553	553	553	553	553
Profit (M£)	-30	-60	-120	-190	-130	308	308	308	308	308	308	308
Cumulative profit (M£)	**1625**											
NPV (M£)	166											



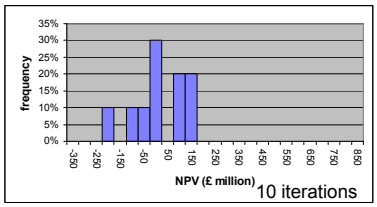
Simulation iteration

DEVELOPMENT OF THE X400

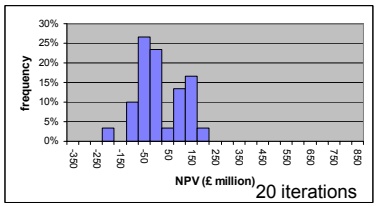
	mean	s.d.	sample									
sales p.a.	24000	4000	17586									
price (£)	18000	1000	18188									
operating fixed costs p.a. (M£)	80	5	77									
marginal cost per car (£)	6200	1000	7768									
discount rate (p.a.)	20%	0%	20%									
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Capital investment (M£)												
design new car	30	50	30									
design production line		10	30	30								
build production line			50	150	100							
establish marketing/distribution			10	10	30							
	30	60	120	190	130	0	0	0	0	0	0	0
Operating costs (M£)												
fixed costs p.a.						77	77	77	77	77	77	77
variable production						137	137	137	137	137	137	137
	0	0	0	0	0	214	214	214	214	214	214	214
Total costs (M£)	30	60	120	190	130	214	214	214	214	214	214	214
Income (M£)												
sales						320	320	320	320	320	320	320
total						320	320	320	320	320	320	320
Profit (M£)	-30	-60	-120	-190	-130	106	106	106	106	106	106	106
Cumulative profit (M£)	**212**											
NPV (M£)	-126											



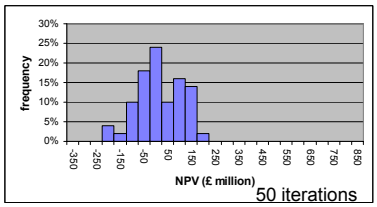
Cumulative simulation output



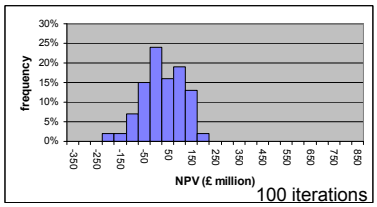
10 iterations



20 iterations

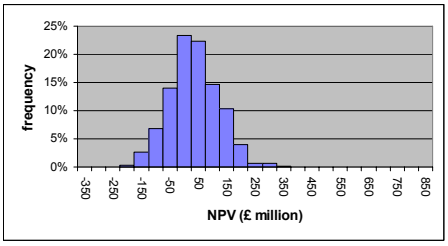


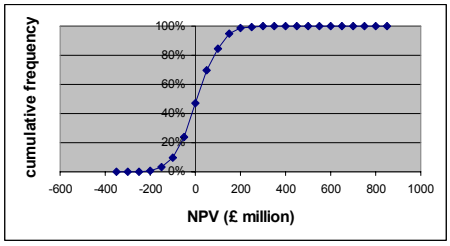
50 iterations



100 iterations

Interpreting Monte Carlo simulation output

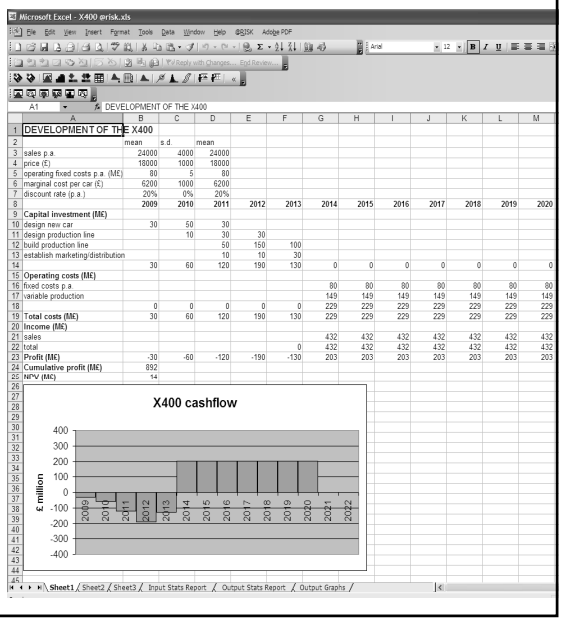




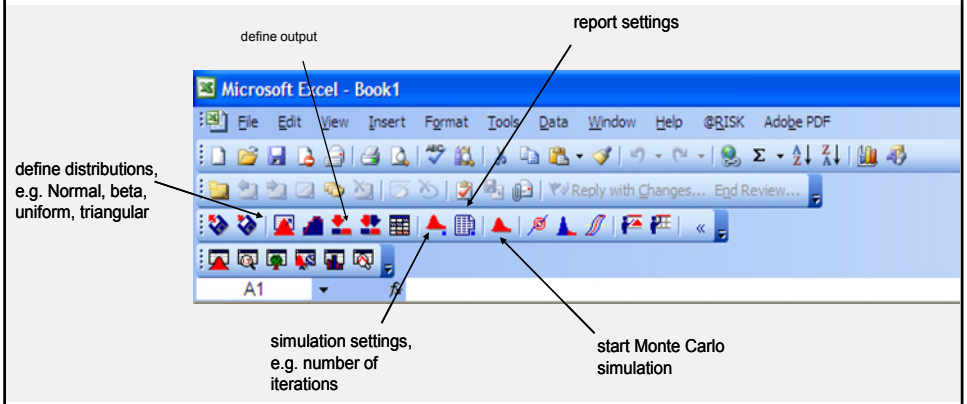
- mean NPV = +£10.2 million
- P(NPV<0) = 47%; P(NPV ≥ 0) = 53%
- mean NPV suggests that the project is viable but simulation analysis reveals high chance of financial failure

@risk

- specialised risk analysis add-on for Excel
- more robust
- more features
- available in all computer labs
- Palisade Decision Tools folder
- 15 day trial download also available:
  http://www.palisade.com/trials.asp



@risk key features



- detailed instructions available on webCT

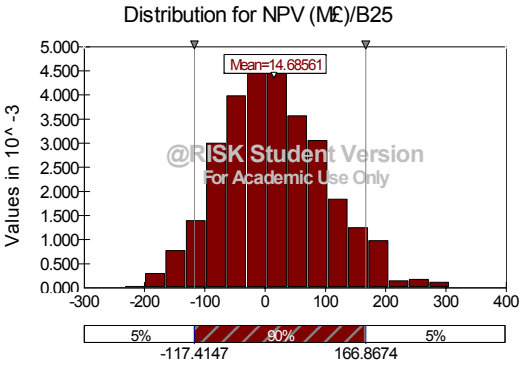
@risk outputs

@RISK Output Details Report

Output Statistics

Outputs	NPV (M£)
Simulation	1
Statistics / Cell	B25
Minimum	-232
Maximum	307
Mean	14.7
Standard Deviation	86
Variance	7423.867409
Skewness	0.295217042
Kurtosis	2.990543667
Number of Errors	0
Mode	-52
5.0%	-117
10.0%	-89
15.0%	-73
20.0%	-59
25.0%	-46
30.0%	-35
35.0%	-23
40.0%	-14
45.0%	-1
50.0%	9
55.0%	20
60.0%	32
65.0%	44
70.0%	56
75.0%	72
80.0%	86
85.0%	106
90.0%	130
95.0%	167
Filter Minimum	
Filter Maximum	
Type (1 or 2)	
# Values Filtered	0
Scenario #1	>75%
Scenario #2	<25%
Scenario #3	>90%
Target #1 (Value)	
Target #1 (Perc%)	

Sheet1 / Sheet2 / Sheet3 / Input Stats Report / Output Stats Report



- detailed input statistics also available to check behaviour