

$$\sum_{g=1}^G \sum_{k=1}^K \left(y_{gk} - \bar{y} \right)^2 = \sum_{g=1}^G k \left(\bar{y}_g - \bar{y} \right)^2 + \sum_{g=1}^G \sum_{k=1}^K \left(y_{gk} - \bar{y}_g \right)^2$$

$$R(t) = e^{-\left(\frac{t}{T}\right)^b}$$

DFSS

An introduction to Six Sigma at IWC

$$f(x) = \frac{1}{\sigma \cdot \sqrt{2\pi}} \cdot e^{-0.5 \cdot \left(\frac{x - \mu}{\sigma} \right)^2}$$

6σ



Content

Introduction.....	3
The Six Sigma timeline.....	4
ISO and Six Sigma.....	5
IWC actions.....	6
Watch industry.....	15
DMAIC or DFSS impact.....	18
Performance.....	20
Product lifecycle.....	23
R&D consequences.....	24
DFSS.....	29
Outlook.....	31



Introduction

Vision

We are the proud engineers of fascinating timepieces from Schaffhausen for demanding people.

Mission

We win the world through outstanding technical milestones and are one of the most desirable premium watch brands.



IWC

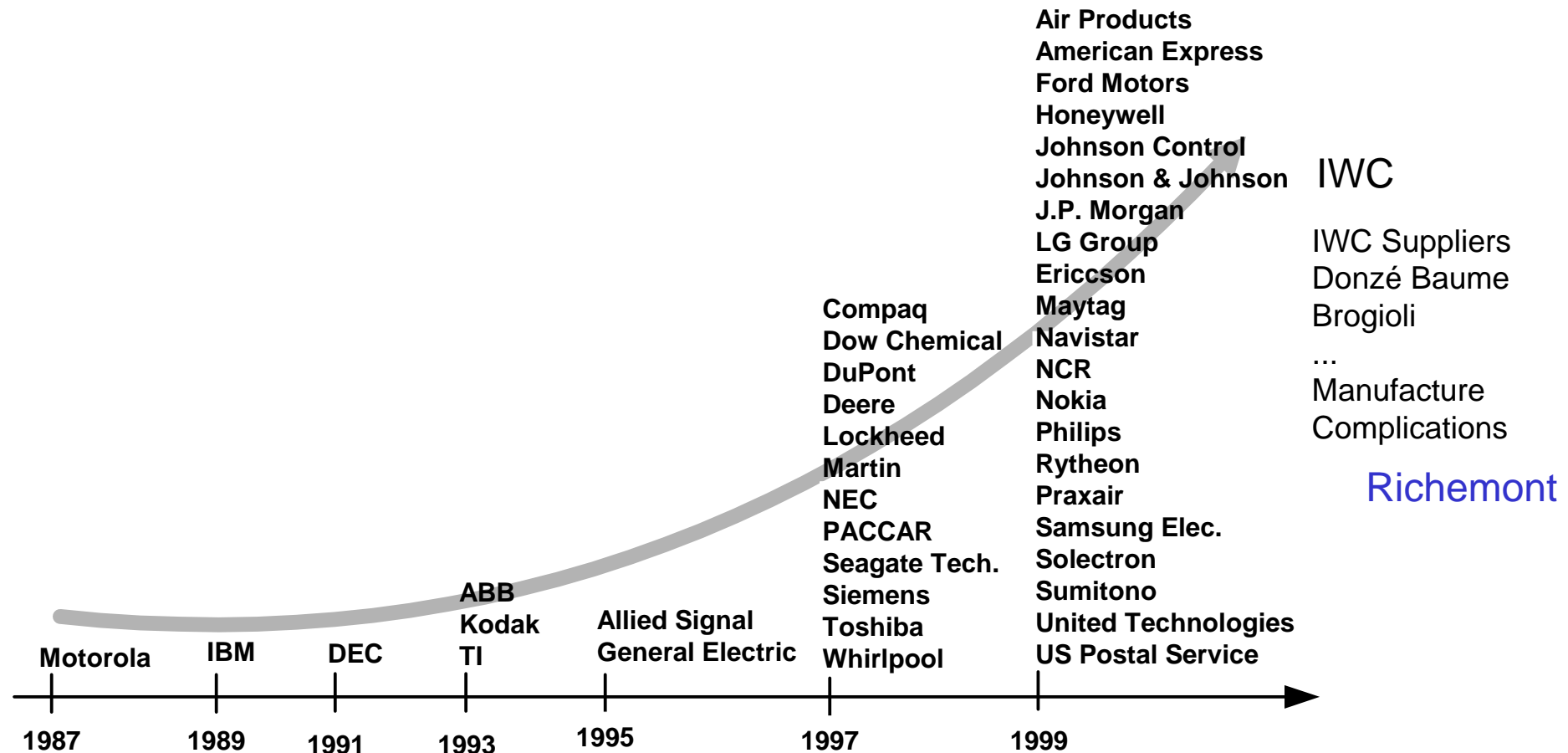
INTERNATIONAL WATCH CO. SCHAFFHAUSEN
SWITZERLAND, SINCE 1868





The Six Sigma timeline

Based on the Fortune 500 list from 1999, 14 of the top 100 companies utilise Six Sigma.





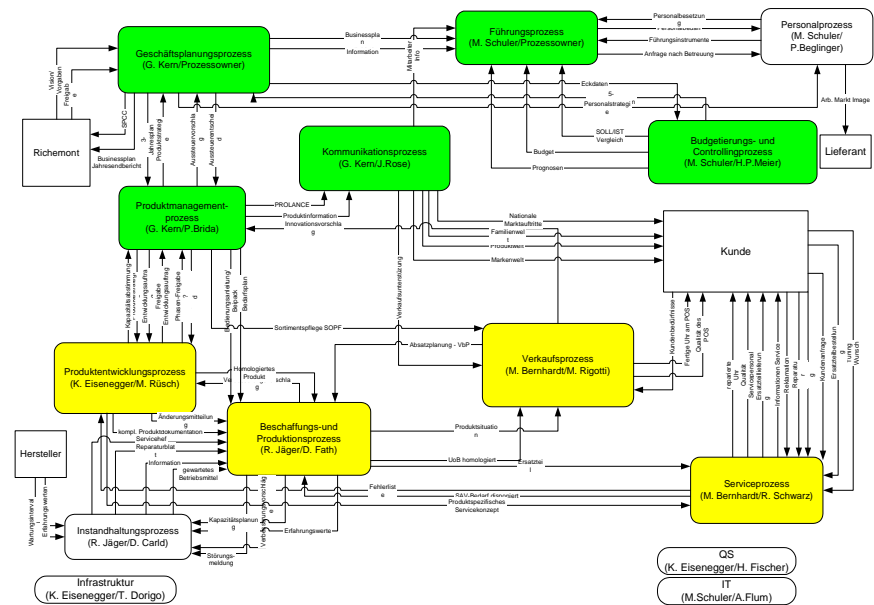
ISO and Six Sigma

- ISO is used to build up processes and process organisation
- With Six Sigma we measure and optimise the processes

We use both systems at IWC



complementary





IWC actions

2003

2004

2005

Black belt
training

DMAIC
project 2002



Aquatimer DFSS project (movement)



Write DFSS training
handbooks

Change R&D process
handbooks

Internal yellow
belt trainings

Internal green belt
trainings



2003

Black belt (DMAIC)
training

DMAIC
project 2002



Where are the defects?
Which methods will help to avoid this defects?
Use these methods for the future projects

DPMO 61904.76
Sigma (with shift) 1.54

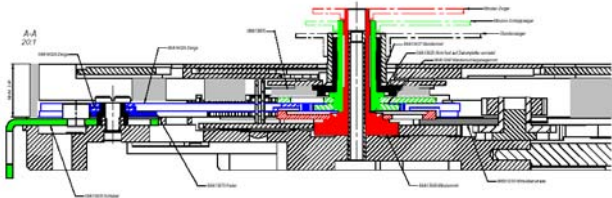
Process Sigma as KPI





DFSS

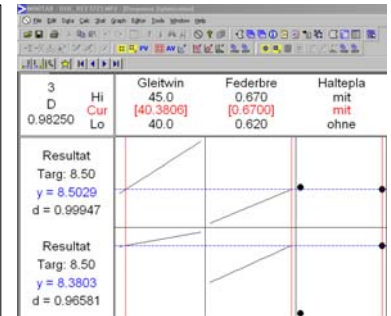
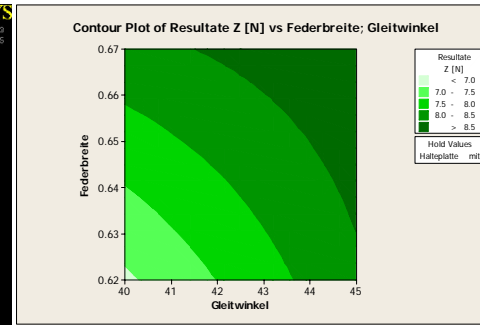
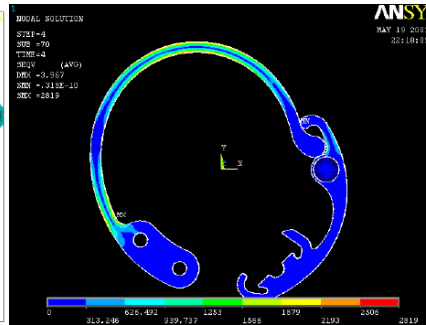
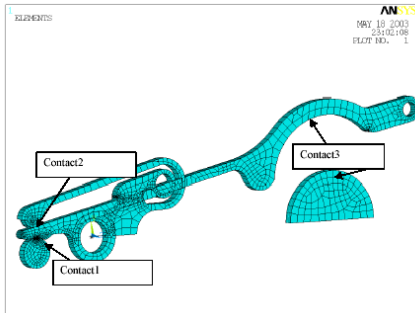
2004



Aquatimer DFSS project (movement)

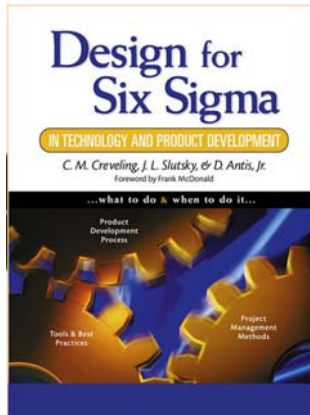


DPMO
Sigma (with shift) >4





Collecting data & information



Kodak Six Sigma "Black Belt"



- [Introduction](#)
- [Training program](#)
- [Six Sigma/10X Champion](#)
- [Project selection](#)
- [Candidate attributes](#)

Throughout the business world, the Six Sigma program has become a leading method to **improve quality, save time, and cut costs**. It applies to all aspects of business, including design, manufacturing, inventory, delivery, and product performance.

Motorola pioneered the Six Sigma concept over 12 years ago, but since 1992 Kodak has been an active participant and a charter member of the Motorola Six Sigma Consortium. We have examined the Six Sigma Black Belt programs of several major companies (including Motorola, Texas Instrument, GE and AlliedSignal), and have taken the best of these programs to form our own program.

At Kodak, Six Sigma Black Belts are expected to:

- Influence change
- Provide leadership in applying quantitative methods
- Facilitate teamwork
- Consult with management
- Transfer knowledge and skills to others
- Discover new leveraging opportunities
- Continuously improve their skills
- Participate in the Kodak Black Belt network



Motorola University

Welcome to Motorola University!

Where Six Sigma® was invented

As Motorola's corporate change agent and a world-renowned corporate university, **Motorola University brings time-tested and highly refined business improvement practices to leading organizations around the world.**

Most notably, as the inventor of the Six Sigma methodology for continuous improvement, Motorola University offers a variety of Six Sigma services designed for speed, results, and sustainability -- whatever the size or nature of your business.

This site is for you if you're looking for...

- Business process improvement services tailored to your organization's needs
- Customized Six Sigma launch support
- Open enrollment Six Sigma Black Belt and Green Belt programs

To learn more about our customizable programs, explore [Our Six Sigma Services](#).



Six Sigma Slogan & Logo

Slogan : "Change for success"

Logo

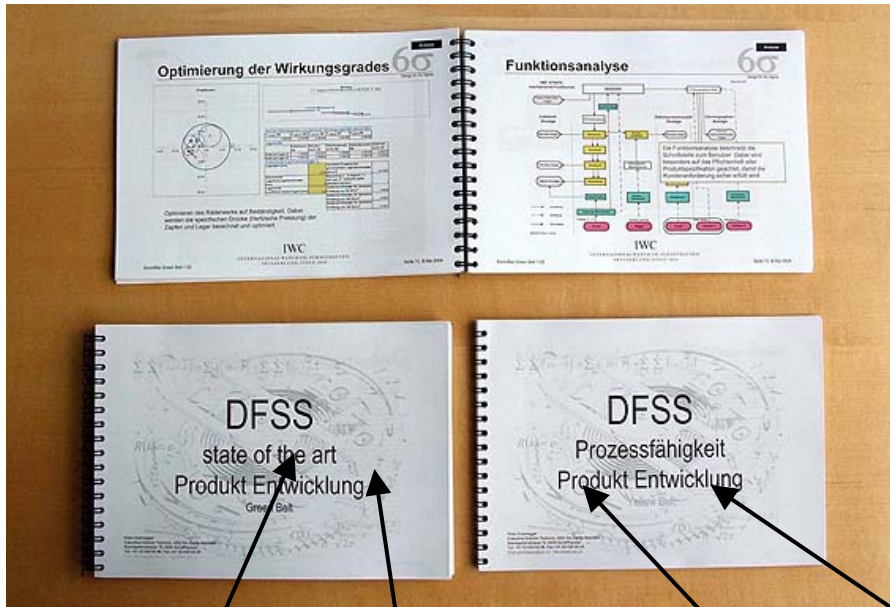
Symbolism



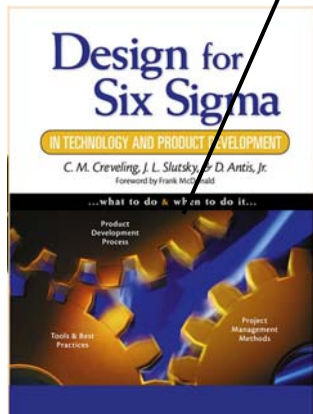
: In the logo, Samsung Corning's three business areas, which are Braun tube glass, coatings and ceramics, are symbolized in the three basic colors of light. Like a flaming torch, the number "1" appears at the center of the logo, which also represents Samsung Corning's goal of achieving world-class competitiveness through the realization of Six Sigma.



Creating own handbooks

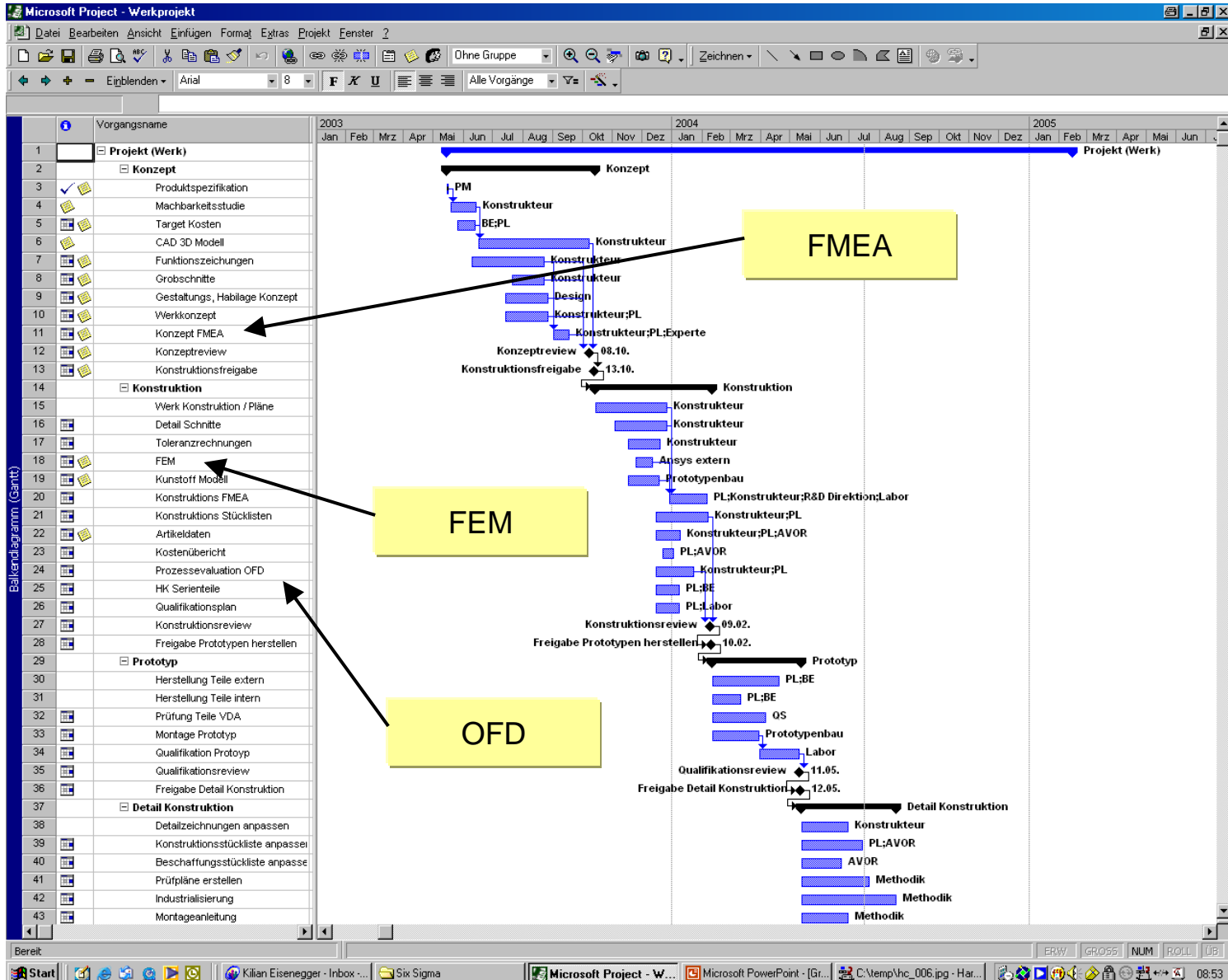


- No existing DFSS standard
- DFSS is relatively new, not as well known as DMAIC
- Most information is only in English
=> translation
- Examples and practices from our own products
- More familiar with our own documentation, not only based on theories, a more pragmatic approach





Process integration





Internal training



Yellow Belt
Process Capability

Green Belt
FMEA, DOE, OFD,
CPM Process evaluation

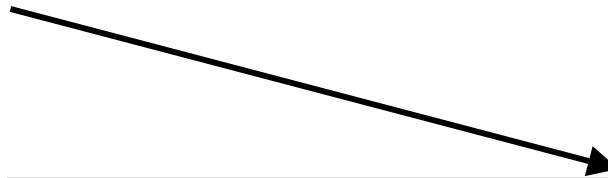


Name	Vorname	A5-Ordner	Prozessfähigkeit	QFD	Prozessevaluation	FMEA
Abad	Amaro					02.07.2004
Bourgeois	Luc	X	26.03.2004	28.04.2004	28.05.2004	
Eschmann	Lorenz		26.03.2004			
Frei	Jonas		07.05.2004			
Güntert	Helmut	X	26.03.2004			
Haumann	Dino					02.07.2004
Ihnen	Stefan	X	26.03.2004	28.04.2004	28.05.2004	
Indlekofer	Christian		07.05.2004	28.04.2004	28.05.2004	
Indlekofer	Thomas		07.05.2004		28.05.2004	02.07.2004
Kaufmann	Markus		07.05.2004			
Kogler	Stefan	X	26.03.2004			
Lurati	Marcus		02.04.2004			
Meister	Hanspeter		07.05.2004			02.07.2004
Metzger	Beat		02.04.2004			02.07.2004
Mojon	Jean-François			28.04.2004	28.05.2004	
Oppold	Matthias		02.04.2004			
Robakowski	Martin		07.05.2004			
Rühli	Severin		02.04.2004			
Schmeckenbecher	René		02.04.2004			
Schweizer	Pascal	X	26.03.2004			
Speichinger	Ferdinand	X	26.03.2004			
Stucki	Bernhard					02.07.2004
Voutat	Joanne	X	26.03.2004			
Zimmermann	Heiko		26.03.2004		28.05.2004	
Zimmermann	Denis			28.04.2004	28.05.2004	
Eisenegger	Kilian	X				
Smit	Martina	X	26.03.2004			



Watch industry

- Traditional industry
- A lot of classic empiric experience
- A lot of variance and individual components

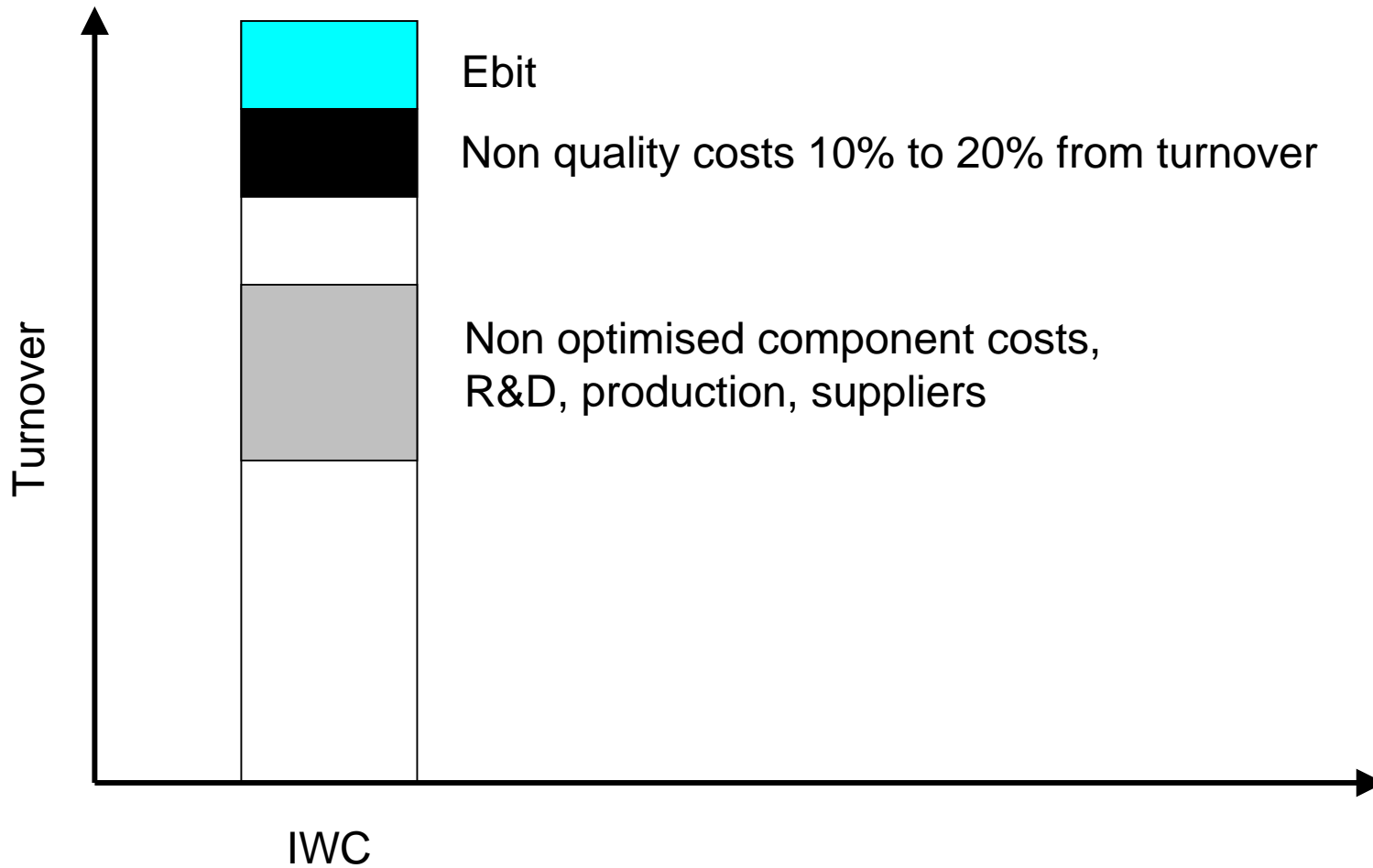


- Modern industry
- Use of new methods
- Build more standards

A mechanical watch has not been significantly improved since 1975, compared to a digital camera where we have each year the double number of pixels. If we make a better watch and increase customer satisfaction, we have to use the same state of art methods

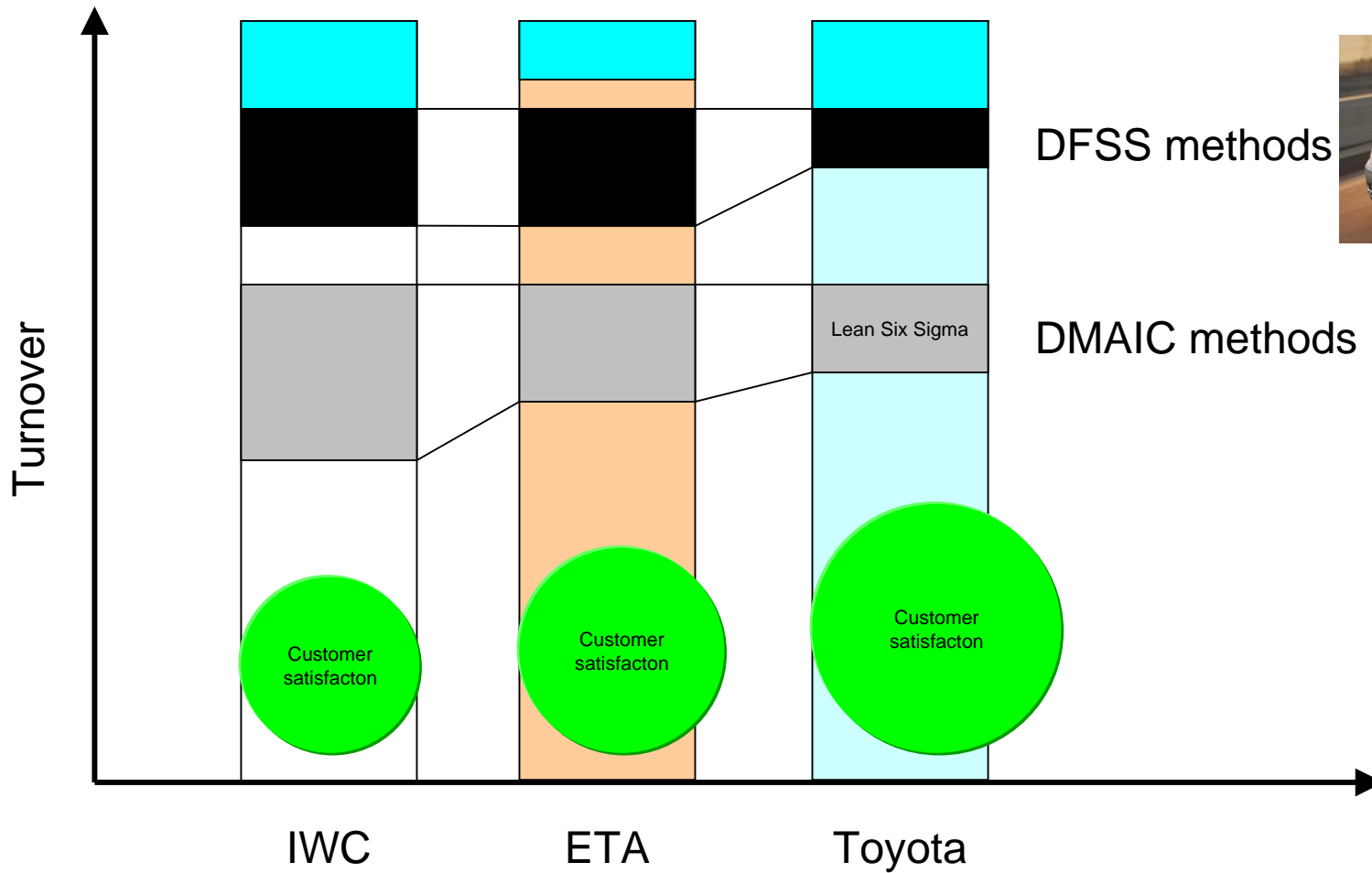


Turnover split, IWC



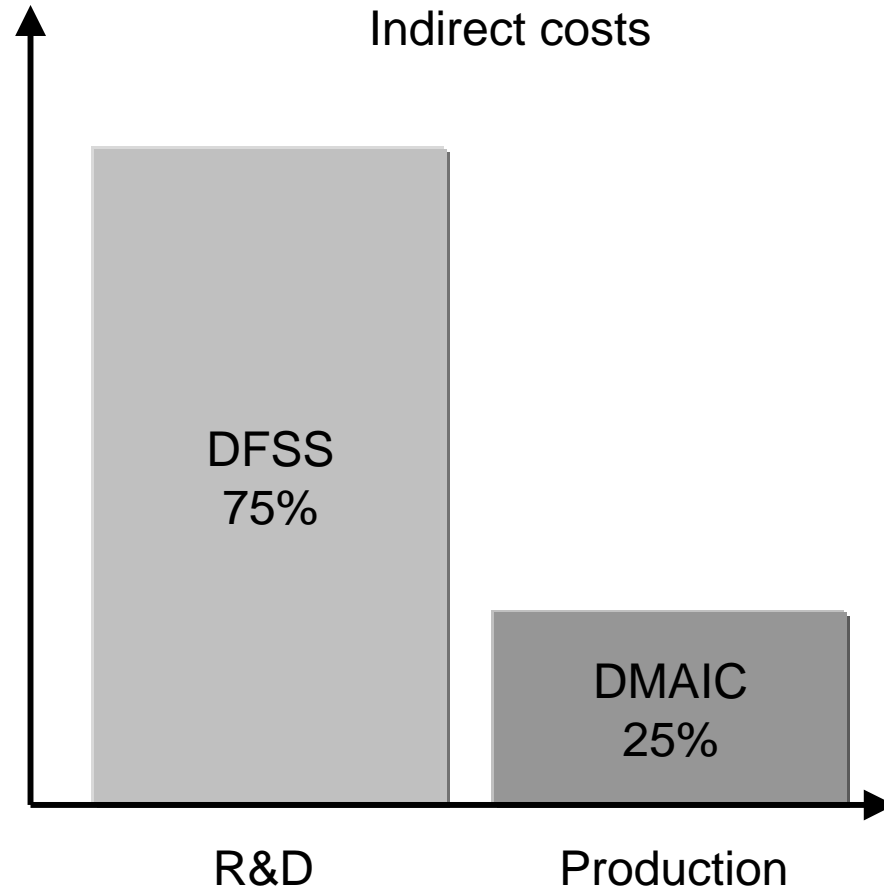


Turnover split, competitors analyses





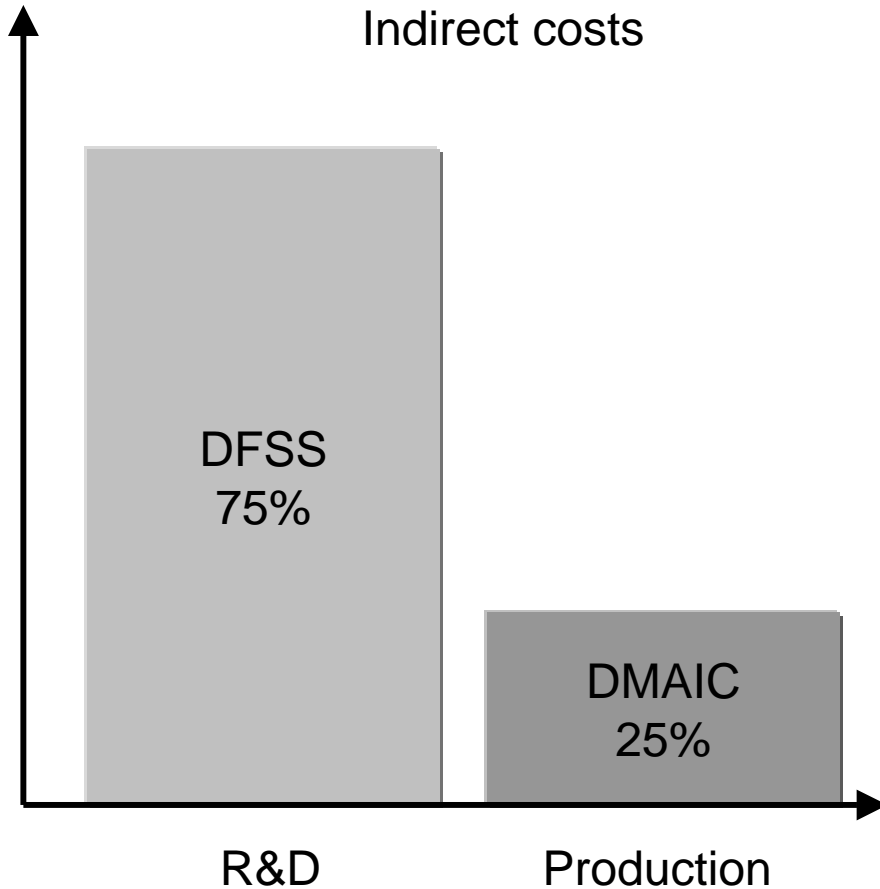
DMAIC or DFSS impact



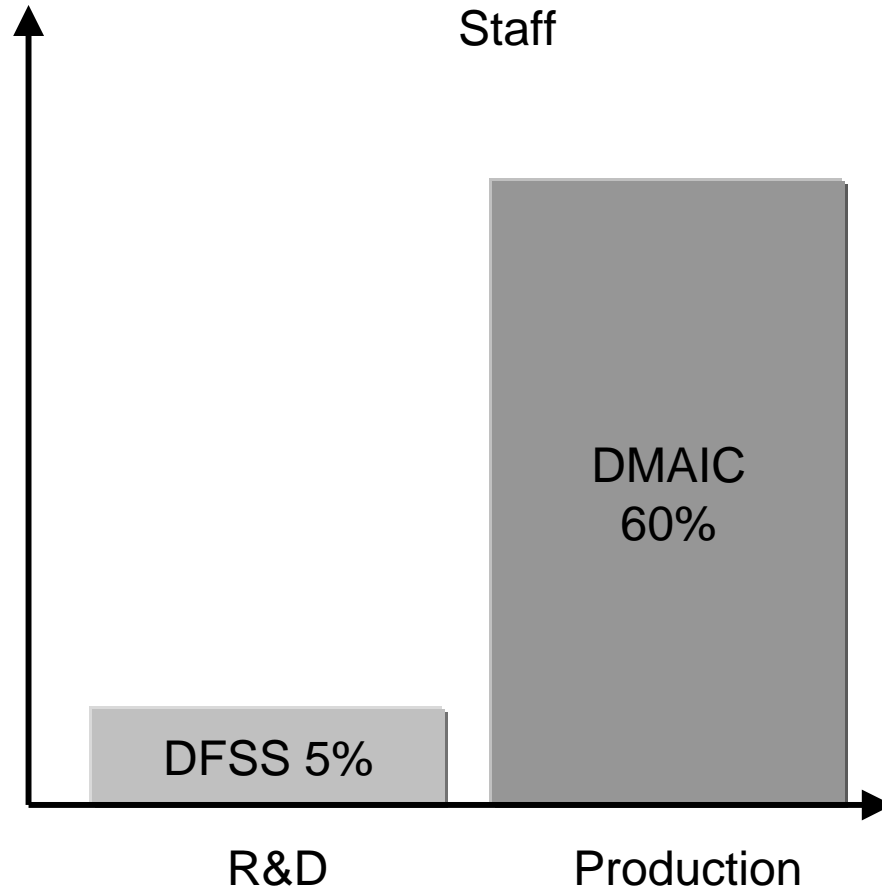


DMAIC or DFSS introduction

Indirect costs



Staff





GE performance



Rank	Name	Country	Sales Rank	Profits Rank	Assets Rank	Market Value Rank
2	General Electric	United States	9	2	21	1
32	Microsoft	United States	111	6	152	2
37	Pfizer	United States	102	4	202	3
4	ExxonMobil	United States	2	1	79	4
11	Wal-Mart Stores	United States	1	10	120	5
1	Citigroup	United States	15	3	1	6
47	Johnson & Johnson	United States	84	14	257	7
6	Royal Dutch/Shell Group	Netherlands	4	8	86	8
7	BP	United Kingdom	5	13	80	9
17	International Business Machines	United States	20	40	122	10

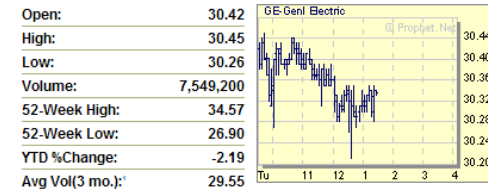
GE took in the first place in market value list of Forbes in 2004 of the 2000 most successful companies (49'492 \$ / employee)

Home > Markets > Equities > General Electric Company

General Electric Company (NYSE: GE)

Industry: **Conglomerates**
Sector: **Conglomerates**

Price: **30.35** Change: **.0500** %Change: **.17**
Tue May 04 2004 13:24 EDT | 15 min quote delay



Charting powered by Prophet.Net
Advanced Chart

Buy, Sell, Hold GE? Get a Second Opinion™

News

- 05.04.04 U.S. stocks near unchanged on pre-Fed meeting caution
 - 05.04.04 U.S. stocks waver near unchanged on caution before Fed
 - 05.04.04 U.S. stocks hover near flat on caution before Fed meeting
 - 05.04.04 Highest-Paid Boards
 - 05.03.04 TV network NBC names new entertainment president
- [More News On General Electric Company](#)

General Electric on the Forbes 2000

	RANK
Conglomerates	2
Sales	\$134.19 bil
Profits	\$15.59 bil
Assets	\$626.93 bil
Market Value	\$328.54 bil
Employees	315,000

Forbes 2000 data as of 02.13.2004

[< Previous](#) [Next >](#)

Chairman & CEO: Jeffrey R Immelt

General Electric
www.ge.com
3135 Easton Turnpike
Fairfield
CT, 068280001
United States

Phone: 203-373-2211

FORBES 2000
CLICK HERE FOR FULL COVERAGE



Toyota performance



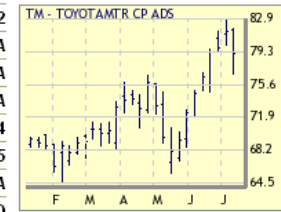
Forbes 2000 Rank	Name	Country	Category	Sales (\$bil)	Profits (\$bil)	Assets (\$bil)	Market Value (\$bil)
8	Toyota Motor	Japan	Consumer durables	135.82	7.99	171.71	115.40

TOYOTA MTR CP ADS



Price: **79.42** Change: **.0000** %Change: **.00**
Fri Jul 16 2004 20:00 GMT | 20 min quote delay

Open: **NA**
Yesterday Close: **79.42**
High: **NA**
Low: **NA**
Volume: **NA**
52-Week High: **82.94**
52-Week Low: **49.65**
Incr Vol: **NA**
Currency Code: **USD**



Charting and all data (except Forbes 2000 data where applicable) provided by
 ComStock

Financials & Ratios	
Book Value/Share (\$)	47.07
Current Ratio (MRQ)	1.16
Div/Yield %	0.9
Earn/Shr (\$)	6.57
Earn/Shr Est	7.22
Ex-Div Amt. (\$)	0.75
Ex-Div Date	03/26
Interim Earnings Period	NA
Market Cap	132,234.30
P/E	12.09
Shares Out	3,330,000
Preferred Shares Out	NA

Toyota Motor on the Forbes 2000

Consumer durables	RANK
	8
Sales	\$135.82 bil
Profits	\$7.99 bil
Assets	\$171.71 bil
Market Value	\$115.40 bil
Employees	264,096

Forbes 2000 data as of 02.13.2004

[< Previous](#) [Next >](#)

Chief Executive Officer:
Fujio Cho

Toyota Motor
www.global.toyota.com
4-18 Koraku 1-chome,
Bunkyo-ku
Tokyo 112-8701
Japan

Phone: 81-3-3817-7111

FORBES
2000
[CLICK HERE FOR FULL COVERAGE](#)

Toyota took place Nr. 8 in the list of Forbes in 2004 of the 2000 most successful companies (30'254 \$ / employee)



Richemont performance



Forbes 2000 Rank	Name	Country	Category	Sales (\$bil)	Profits (\$bil)	Assets (\$bil)	Market Value (\$bil)
548	Richemont	Switzerland	Household & personal products	3.95	0.79	7.72	13.98

Home > Markets > Equities > COMPAGNIE FINANC RIC

COMPAGNIE FINANC RIC



Price: **25.30** Change: **.0000** %Change: **.00**
15 min quote delay

Open:	NA
Yesterday Close:	25.30
High:	25.75
Low:	25.25
Volume:	4,848
52-Week High:	28.00
52-Week Low:	18.50
Incr Vol:	NA
Currency Code:	USD



Charting and all data (except Forbes 2000 data where applicable)
provided by ComStock

Financials & Ratios

Book Value/Share (\$)	5.13
Current Ratio (MRQ)	1.81
Div/Yield %	1.3
Earn/Shr (\$)	1.40
Earn/Shr Est	NA
Ex-Div Amt. (\$)	0.35
Ex-Div Date	09/24
Interim Earnings Period	NA
Market Cap	26.41
P/E	18.07
Shares Out	1,044
Preferred Shares Out	NA

Richemont on the Forbes 2000

Household & personal products	RANK
	548
Sales	\$3.95 bil
Profits	\$0.79 bil
Assets	\$7.72 bil
Market Value	\$13.98 bil
Employees	14,978

Forbes 2000 data as of
02.13.2004

< Previous Next >

Chief Executive Officer: Johann Rupert

Richemont
www.richemont.com
8 Boulevard James
Fazy
CH-1201 Geneva
Switzerland

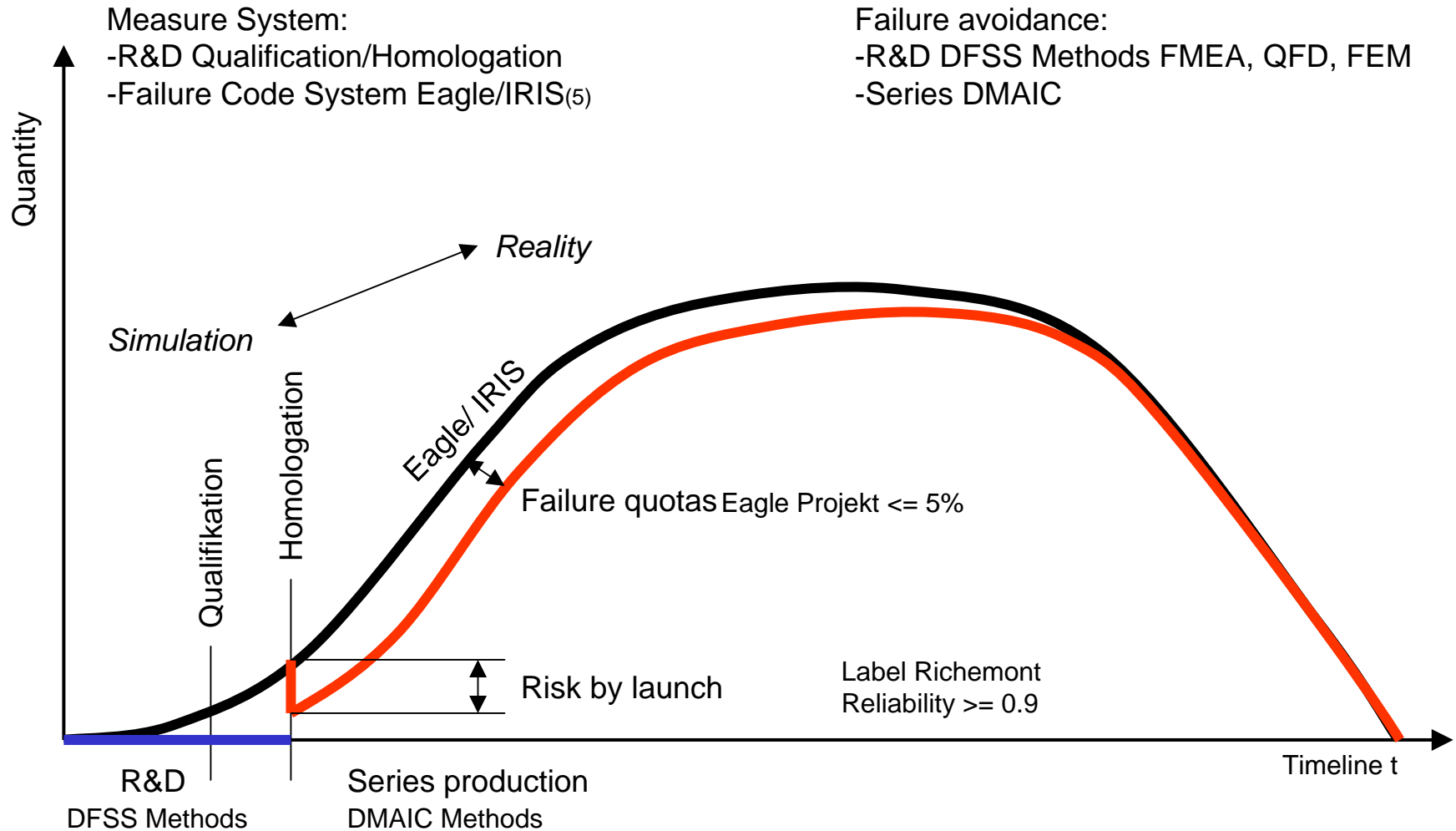
Phone: 41-22-715-3500



In comparison Richemont on the 548 place and Swatchgroup on the 933. (52'744 \$ / employee)

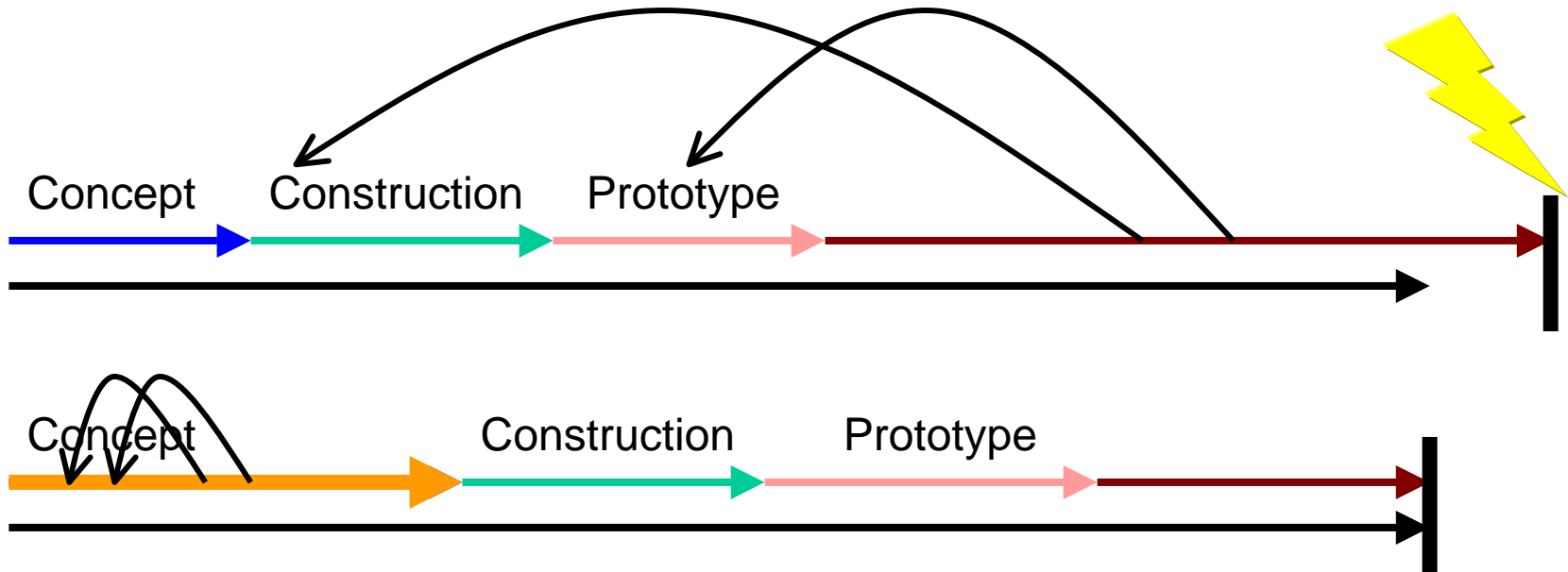


Product lifecycle



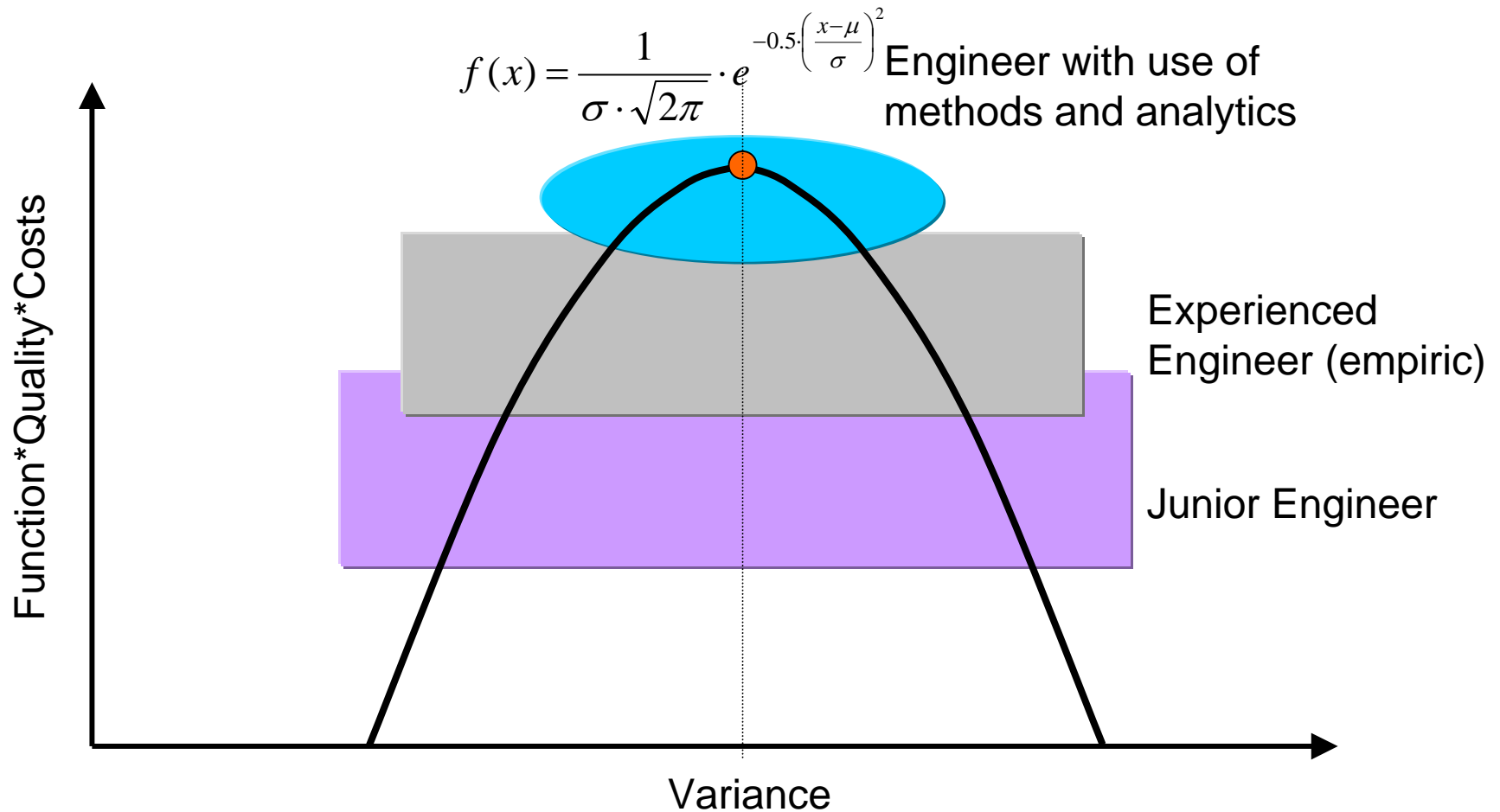


R&D consequences





Use of experience





Supplier commitments

IWC
International Watch Co. Schaffhausen, Switzerland
Since 1868

Six Sigma Quality System

Define Measure Analyse Improve Control

Eliminate waste
Eliminating non-value activities from process

Optimise process
D - define customer needs and goals
M - measurement of process
A - data-analyses to establish inputs and outputs
I - improve system elements to achieve performance goals
C - control of key values to sustain the gain

Design for Six Sigma DFSS
Want to move our organisation to the next level of performance

Commitment

The supplier confirms with this document to enter into the commitment to make an effort for implementing and retaining the Six Sigma Quality System for the production of parts to IWC Schaffhausen.

Place, date: 10.1.2003 Place, date: Schaffhausen 9 Jan 2003
Brogioli SA IWC Schaffhausen

Brogioli [Signature]

IWC
International Watch Co. Schaffhausen, Switzerland
Since 1868

Six Sigma Quality System

Define Measure Analyse Improve Control

Eliminate waste
Eliminating non-value activities from process

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D - define customer needs and goals
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Design for Six Sigma DFSS
Want to move our organisation to the next level of performance

Commitment

The supplier confirms with this document to enter into the commitment to make an effort for implementing and retaining the Six Sigma Quality System for the production of parts to IWC Schaffhausen.

Place, date: Les Brenets, 13 janvier 03 Place, date: Schaffhausen 9 Jan 2003
Donzé-Baume SA IWC Schaffhausen

[Signature] [Signature] [Signature] [Signature]



Design optimise analyse verify

- Design** translates the customer CTQ's into functional requirements and into alternative solutions. A selection process whittles down the list of solutions to the "best" solution
- Optimise** uses advanced statistical tools and modelling to predict and optimise the design and performance
- Analyse** the process options to meet the customer needs
- Verify** the design performance and ability to meet customer needs

Design Optimise Analyse

VOC CTQ's

QFD

Analyse

C&E FMEA

CPM

Process Evaluation

Verify

Homologation

SPC

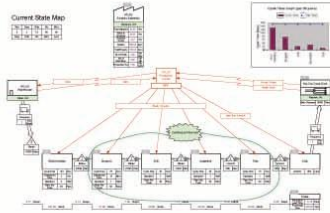


Impacts





DFSS



Production control
- Maintain capable processes - approach a Six Sigma operation
- Lean Manufacturing

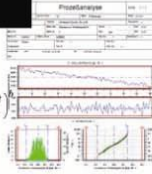
SPC

Qualification and Homologation
- Meantime between Failure MTBF
- Stress, shocks, climatic tests



Homologation

$$F(t) = 1 - e^{-\frac{t}{MTBF}}$$

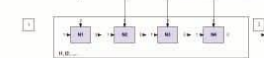


Process evaluation and selection
- Capability of a process
- Evaluate and select production methods

$$DPMO = \frac{D}{N \cdot O} \cdot 10^6$$

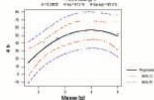
Process evaluation

$$Cm = \frac{T}{6s} = \frac{OSG - USG}{6s}$$



Item	Value	Unit	Comment
1	100	mm	Length
2	50	mm	Width
3	20	mm	Height
4	10	mm	Radius
5	5	mm	Thickness
6	2	mm	Gap
7	1	mm	Clearance
8	0.5	mm	Surface finish
9	0.2	mm	Micro-finish
10	0.1	mm	Texture

CPM Critical Parameter Management
- Energy, force, pressure
- Mathematic parameters
- Component Lifecycle
- DOE Design of experiments



$$y = f(x_1, x_2, \dots, x_n)$$

CPM



DFSS

Design for Six Sigma

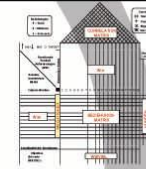
VOC CTQ's

Understanding and Anticipating Customer's Needs
- Basic Needs (expected needs, yet unspoken)
- Performance Needs (Spoken needs)
- Excitement Needs (Innovations, "WOWs")

IWC	Kundenwünsche/CTQ's	IWC CTQ's
Qualität der Fertigung	Qualität der Fertigung	Qualität der Fertigung
Qualität der Komponenten	Qualität der Komponenten	Qualität der Komponenten
Qualität der Materialien	Qualität der Materialien	Qualität der Materialien
Qualität der Montage	Qualität der Montage	Qualität der Montage
Qualität der Verpackung	Qualität der Verpackung	Qualität der Verpackung
Qualität der Dokumentation	Qualität der Dokumentation	Qualität der Dokumentation
Qualität der Service	Qualität der Service	Qualität der Service
Qualität der Logistik	Qualität der Logistik	Qualität der Logistik
Qualität der Kommunikation	Qualität der Kommunikation	Qualität der Kommunikation
Qualität der Zusammenarbeit	Qualität der Zusammenarbeit	Qualität der Zusammenarbeit



QFD

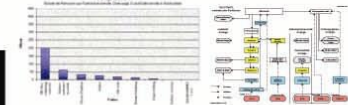


The QFD "House of Quality"
- Create a well documented and prioritised list of requirements to keep them current and visible.
- Develop, metrics and specific goals for customers requirements.

Item	Value	Unit	Comment
1	100	mm	Length
2	50	mm	Width
3	20	mm	Height
4	10	mm	Radius
5	5	mm	Thickness
6	2	mm	Gap
7	1	mm	Clearance
8	0.5	mm	Surface finish
9	0.2	mm	Micro-finish
10	0.1	mm	Texture

Analyse

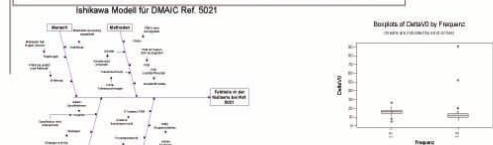
"Value" Analysis
- Terms of Functions
- Engineering system and its problems



C&E/FMEA

Cause & Effects // Failure Modes & Effects Analysis
- Assure your product and processes perform their intended functions over their entire life span.

$$Cp = \frac{T}{6s}$$



$$f(x) = \frac{1}{\sigma \cdot \sqrt{2\pi}} \cdot e^{-0.5 \left(\frac{x-\mu}{\sigma} \right)^2} \quad s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$



IWC and DFSS today

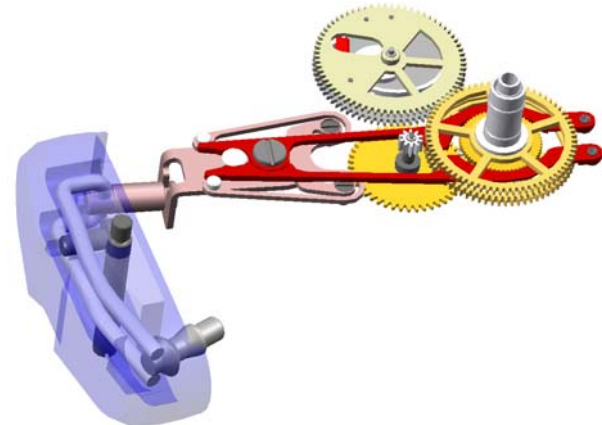
Reached targets	😊	😞
Reduction failure rate before mass production	x	
Know customers need, no changes of specification	x	
After sales service statistics implementation in R&D		x
Price optimisation into process evaluation => process capability		x
Time to market, no conceptual defects	x	
Customer satisfaction	To be proved	

Used methods for DFSS:

VOC>CTQ, SIPOC, Gage R&R, QFD, FMEA, OFD, DoE, ANOVA, F-Test, T-Test, CPM, SPC



IWC 6σ start with Ref. 3723





2004

2005

2006

IWC

All R&D projects with DFSS project

CAQ Böhme & Weihs implementation with SPC

Richemont

Approve DFSS as Richemont group standard

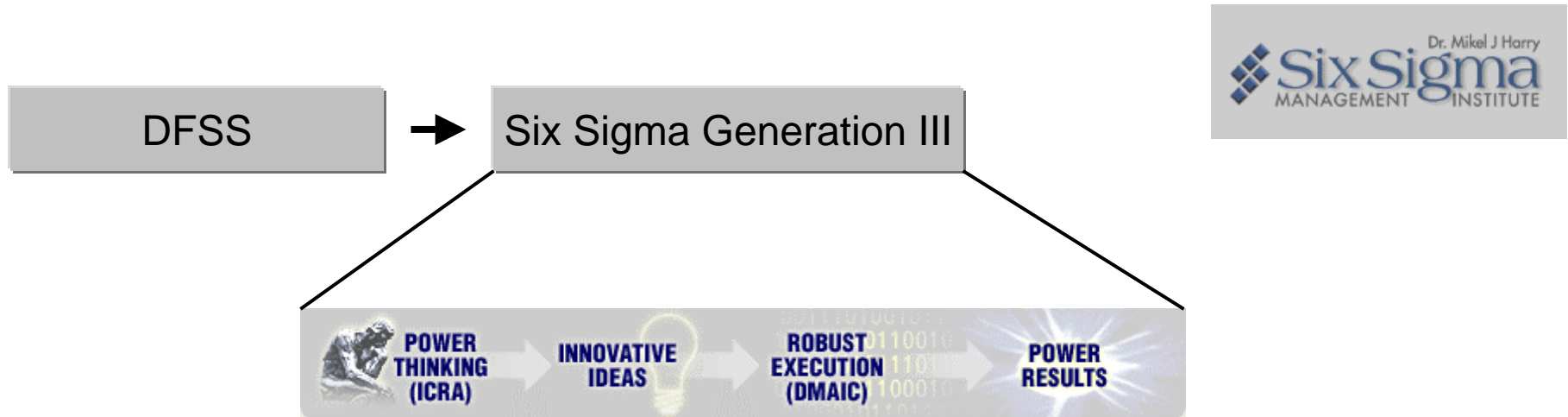
Richemont yellow belt trainings

Richemont green belt trainings



Add ons

Six Sigma Generation III.....	3
Six Sigma in small companies.....	4



ICRA (Innovate, Configure, Realize, Attenuate)

This model helps one to think through any issues - personal or business that require solutions.

The **ICRA** Power Thinking model follows the following pattern:

- **Innovate Growth** - by recognizing value needs and defining change opportunities
- **Configure Goals** - by measuring existing conditions and analysing contributing forces to these conditions
- **Realize Gains** - by improving action settings and controlling input variables
- **Attenuate Gaps** - by standardizing success factors and integrating lessons learned.

Power Thinking with ICRA produces innovative ideas; robust execution (DMAIC) of the innovative ideas produces powerful results.



Small companies and Six Sigma



Top down or bottom up

(Mikel J. Harry) For small companies it's got to go the other way. It's got to bubble up.

Here's how: Suppose I'm an individual in a company that's not doing Six Sigma. But maybe if I do it, and do it well, people will follow my example. And besides, being a Black Belt, I'll make more money. So I'm going to become a Black Belt, put more money in my pocket, and by doing well, maybe I can get my company to start using it. So the reasoning process is from the individual up instead of from the CEO down.

The goal is not to deploy it. The goal of flow-down is deployment and implementation. That's what I mean when I say Six Sigma is changing its shape and character. Six Sigma is no longer being promoted by the likes of Jack Welch, Larry Bossidy, Bob Galvin and other executives. They've said their piece. They've benefited from it. Now we see surveys being done that show Black Belts make more money. We're seeing people say, I want to be a Black Belt; my company is not doing it. How do I get trained? We're seeing an individual interest.