

There is a common understanding that 70-90% of products manufacturing costs are determined in the design phase.

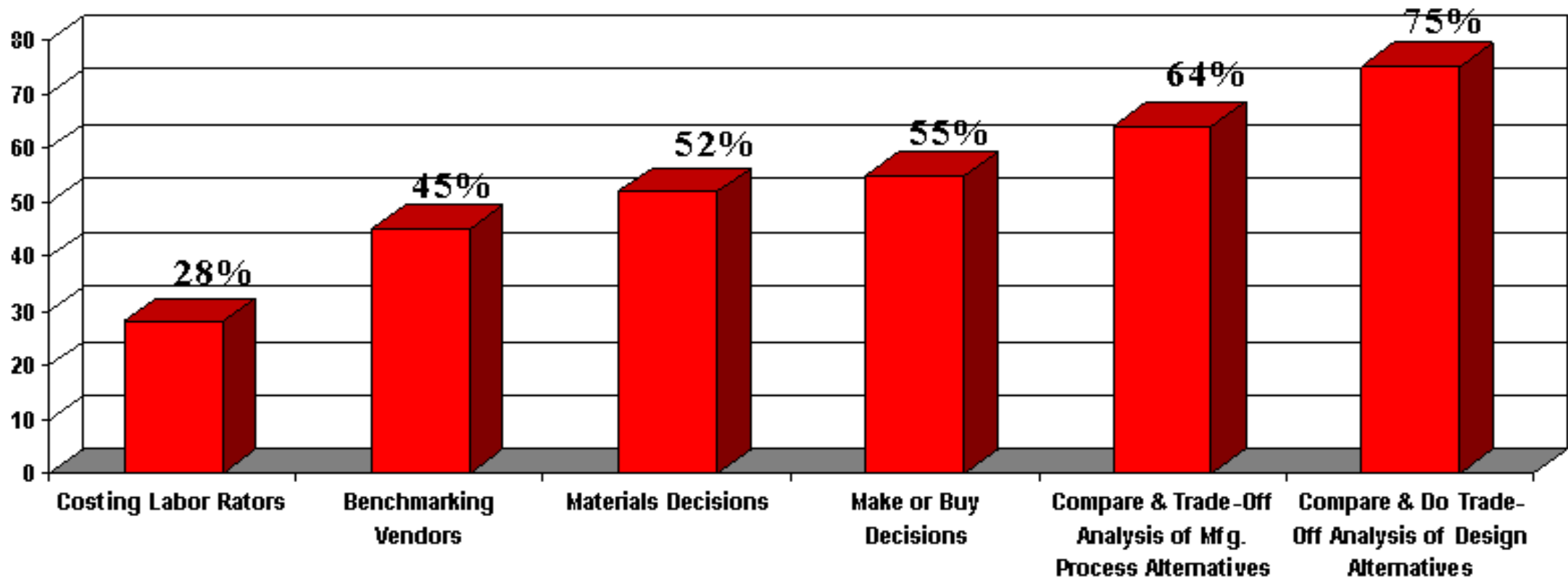
The use of automated assembly has to be decided in the product design phase, thus preventing later problems in manufacturing.

DFA-Tool®

The DFA, Design For Assembly, software tool for evaluating product assemblies early in the design phase

Topics for DFA use in companies

according to a study by Galorath Inc.,1999



DFA-Tool fits perfectly for all the topics (except materials decisions)

Modelling the assembly work according to a sketch, idea or prototype in an Extended Bill Of Materials, EBOM

the product with specifications



is modelled and analysed as:

parts

use of assembly actions

use of assembly tools

subassemblies

Software main view and assembly tree in EBOM

The screenshot displays the DFA-Tool software interface. On the left, a table provides initial data and calculated results. The central area shows an Extended Bill of Materials (EBOM) for 'Perusversio' with a tree view of subassemblies and parts. On the right, a 'Libraries' panel lists parts like 'Smaller window gasket' and 'Support gasket'. A toolbar at the top contains icons for assembly and disassembly directions.

Initial data	
Annual capacity (pcs/yr)	100 000
Investment return time (yr)	3,0
Investment interest rate (%)	12,00
Work costs per hour (€)	15,00
Learning adjustment factor	1,00
Operator adjustment factor	1,00
Manual work hours (h/yr)	1 500
Machine work hours (h/yr)	3 000
Calculated results	
Assembly index	33,89
Assembly time (s)	353,18
Parts	47
Parts (pcs)	26
Modules (pcs)	4
Part prices (€)	160,36
Part weights (g)	67,30
Part volume (%)	100,000
Manual work cost (€)	1,547
Assembly person count	6,876
Investment cost (€)	0,004
Initial investment (€)	1 000
-	-
Robot need (pcs/in use)	
ABB1	1 / 0,04
-	-
Tool need (pcs/usage)	
Ruuviväärin: Automaatin...	1 / 0,81

EBOM		
Perusversio altogether	353,2s	1,547 €
Outer flip A-cover subassy	(1)	3,9s 0,016 €
Bigger window	(1)	3,0s 0,01
Bigger window gasket	(1)	6,0s 0,02
Support gasket	(1)	5,0s 0,02
Turn 180 degrees	(1)	3,0s 0,01
Loudspeaker felt	(1)	6,2s 0,02
Magnet knob	(1)	8,7s 0,03
Outer flip A-cover	(1)	4,1s 0,01
Chrome pin	(1)	4,8s 0,02
Outer flip B-cover subassy	(1)	3,9s 0,016 €
Hinge subassembly	(1)	3,9s 0,004 €
Locking bushing	(1)	5,8s 0,02
Helical spring	(1)	5,0s 0,02
Hinge base	(1)	3,0s 0,01
Hinge torque end	(1)	5,2s 0,02
Flip motor	(1)	3,0s 0,01
ABB1	(0,036)	
Inner flip B-cover subassy	(1)	3,9s 0,016 €
Inner flip A-cover	(1)	3,6s 0,015 €
Foil with connector over	(1)	8,4s 0,035 €
Key pad	(1)	5,2s 0,021 €
Key connect pad mat	(1)	3,0s 0,013 €
Turn 180 degrees	(1)	3,0s 0,013 €
System PWB	(1)	3,9s 0,016 €
Star headed screw	(2)	0s 0 €

Initial data

Assembly/
disassembly
direction

Libraries

Summary
results

EBOM

Product assembly costs initialisation

These basic settings are used to calculate the assembly costs for the product.

Parameter	Value
Currency used in calculations of costs:	€
Annual production (pcs/yr):	100000
Investment payback time (yr):	3
Interest rate of investment (%):	12
Assembly cost per hour:	15
Learning adjustment (0.1 ... 1):	1
Operator adjustment (0.1 ... 1):	1
Manual work hours per annum (h/yr):	1500
Machine work hours per annum (h/yr):	3000

Buttons: Cancel, Save

Part characteristics

Information of what kind of special attention is needed when handling the specific part. If a measured standard time is available, the software calculated time estimate can be withdrawn.

Part characteristics

Name:

Price and currency: €

Weight (g):

1. Basic characteristics | 2. Small part properties | 3. Automation characteristics

Part is a small part (less than 10 mm x 10 mm x 10 mm)

Orientation is difficult to detect

Part is fragile

Part is flexible, no rigid shape

Part is sticky or high friction

Other handling difficulties (sharp, hot etc.)

Measured standard assembly time (s)



Cancel Save

Part characteristics

Automation characteristics can be defined for every part individually

Part characteristics

Name:

Price and currency: € Weight (g):

1. Basic characteristics | 2. Small part properties | 3. Automation characteristics

Price of the feeding head (€):

Quality (yield %):

Fragility:

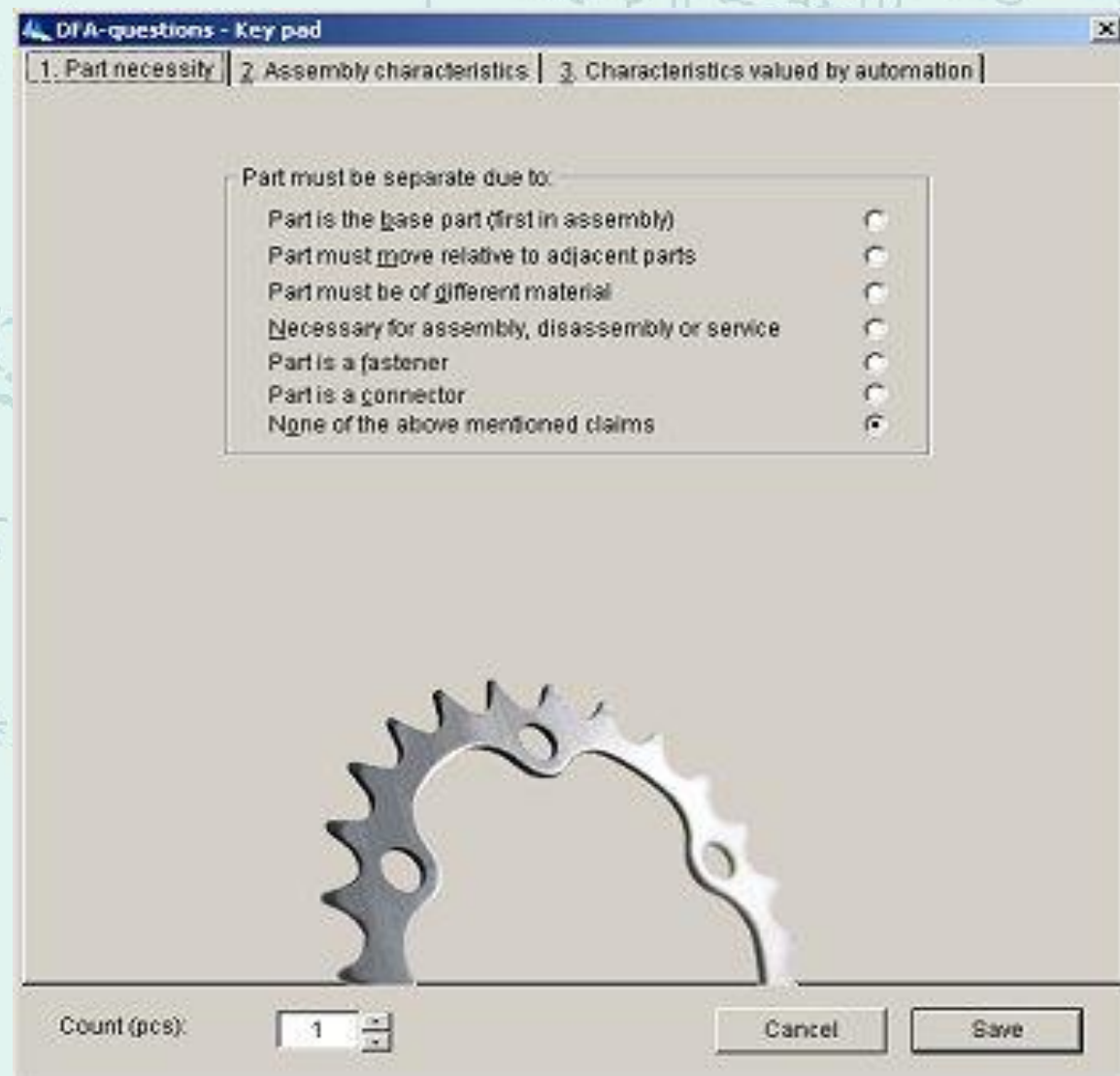
Depth/diameter:

Length:

Tolerances:

Part assembly characteristics (1)

Every part's necessity in assembly is verified in order to optimize the part count and calculate the assembly index.



Part assembly characteristics (2)

Possibility for using automated assembly is evaluated with a set of parameters


DFA-questions - Key pad

1. Part necessity | 2. Assembly characteristics | 3. Characteristics valued by automation

Means for fastening	Snap, screw, adhesive
Possible piling	Yes
Parts sticking together in piles	No
Assembly direction	From top
Holding by assembly	Yes
Chamfers	Yes
Assembly force	20 N < F < 60 N, F = force
Assembly movement	Straight manipulation

Count (pcs): 1

Cancel Save



Defining an assembly tool

Tools that are needed in the assembly can be specified. They can be also obtained from the tool library.

The screenshot shows a 'Tool' dialog box with the following fields and values:

- Name: Hammer
- Price and currency: 6,00 €
- Capacity (pcs/h): 5,50 (radio button is unselected)
- Cycle time (s): 5,50 (radio button is selected)
- Tool handling time (s): 3,00
- Repeats: 2

Buttons: Cancel, Save

Defining an assembly action

Actions that are performed during assembly work can be specified

Action

Name of action:

Units

Unit of action

Time per unit (s)

Number of repeats

Reorientation

Screw fastening analysis

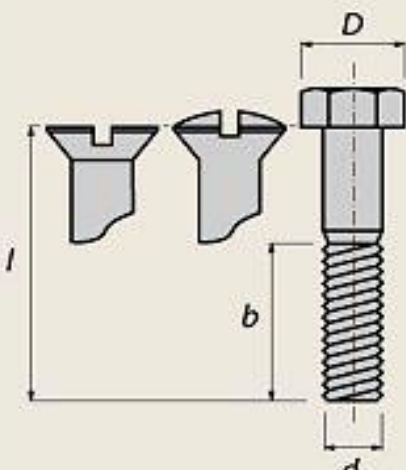
Screw

Name: Screw

Price and currency: 0,100 €

Weight (g): 30,000

1. Basic characteristics | 2. Screw feeding and results



Metric thread (d): M8

Toolhead: Pozidriv

Screw material: Steel

Thread length (b) (mm): 5,0

Screw length (l) (mm): 7,0

Rotational speed (rpm): 300,0

Metric fine pitch thread

Thread locking compound

Count (pcs): 2

Cancel Save

Screw

Name: Screw

Price and currency: 0,100 €

Weight (g): 30,000

1. Basic characteristics | 2. Screw feeding and results

Screw feeding

Screw feeding method: Automatic feed

Screw head width (D) (mm): 12

The mass of the screw is less than 100g

Chosen feeding method is functional

Results

Max torque for screw fastening (Ncm): 290

Screwing time (s): 13,2

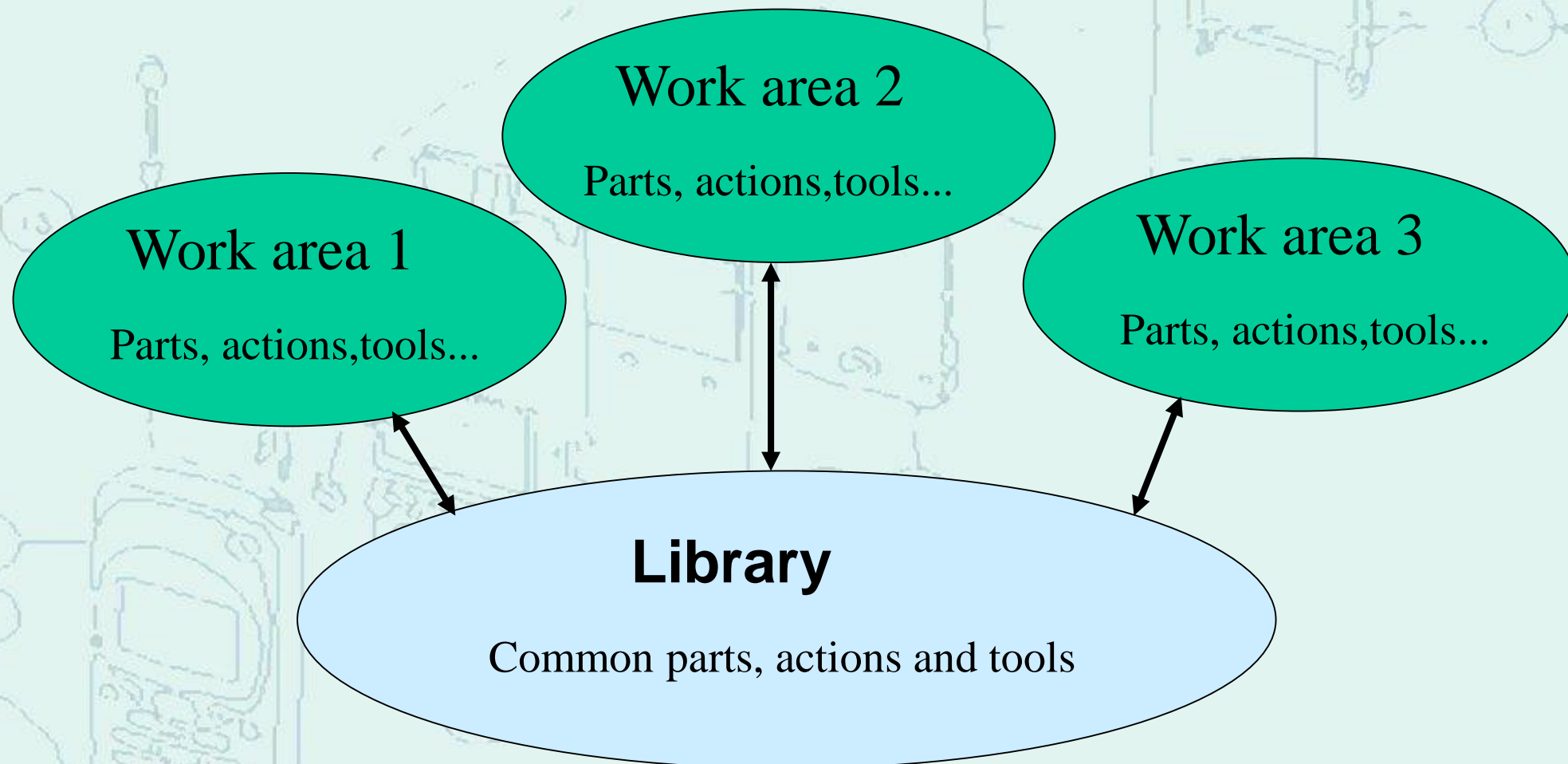
Count (pcs): 2

Cancel Save

Screw is the most common assembly fastener: the software calculates the screwing time and max torque that can be utilised to select the available tool.

Working areas and library

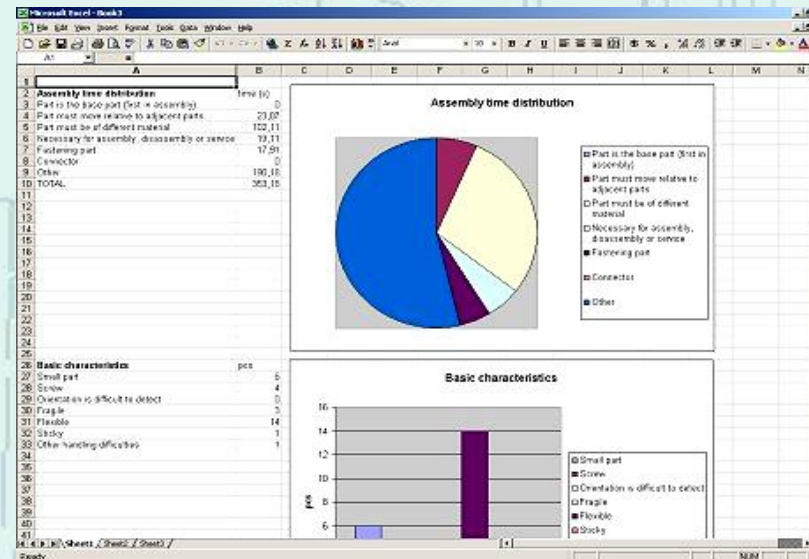
If there are commonalities between parts, actions or assembly tools, they can be saved in the library for later use.



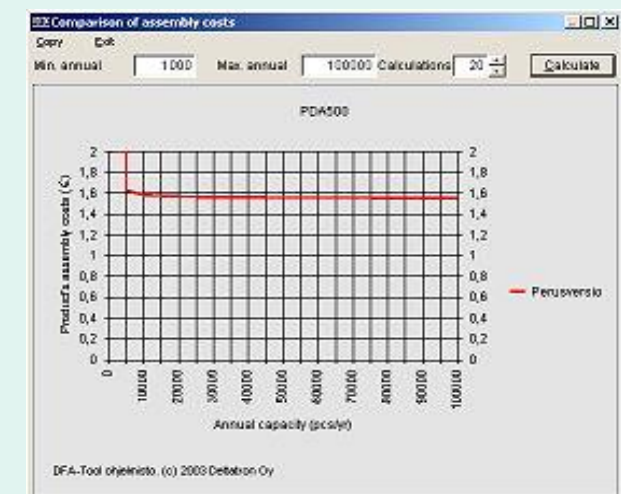
Results

The results of assembly analysis can be observed in many different formats

The software has direct compatibility with web browsers and Ms-Excel®



Element	Amount	Time (s)	Work cost (€)	Percent needed	Investment (€)	Sum of part prices	Sum of part weights (g)
Outer flip A-cover subassy	1	3,90	0,016	0,072	0	29,530	7,330
Outer flip A-cover subassy subassembly	1	40,85	0,170	0,756		29,530	7,330
Outer flip B-cover subassy	1	3,90	0,016	0,072	0	25,820	6,050
Outer flip B-cover subassy subassembly	1	29,42	0,123	0,545		25,820	6,050
Hinge subassembly	1	3,90	0	0	0,004	14,080	9,800
Hinge subassembly subassembly	1	22,82	0,095	0,423		14,080	9,800
Inner flip B-cover subassy	1	3,90	0,016	0,072	0	30,020	9,360
Inner flip B-cover subassy subassembly	1	69,07	0,288	1,279		30,020	9,360
Inner flip A-cover	1	3,62	0,015	0,067	0	17,400	5,160



DFA-Tool ver 4.0. is now available!

**The web site www.dfa-tool.eu
will tell you more...**

**The motivation for product
assemblability development can also
be found at www.suxee.fi**