

Methodics in product development II: Morphology matrix approach in rehab design

MEDTEC 2012

Dr. Oliver Schwarz





Agenda

I Introduction

II Simple example

III Transfer to rehab design

IV Realisation

V Summary



Morphological Analysis and Matrix Analysis -Tools for creating new products and services

Method

- **Morphological thinking** means: to think in structures and order
- **Morphological analysis** was designed for multi-dimensional, non-quantifiable problems where causal modeling and simulation do not function well or at all.
- **Fritz Zwicky** (1898-1974) developed this approach to seemingly non-reducible complexity¹.
- The method of the **morphological box** gives users the confidence to consider all essential solutions
- Search for solutions either **in a heterogeneous group**, which should have a special problem-related knowledge **or as an individual**

•1 Zwicky, F., Discovery, Invention, Research - Through the Morphological Approach, Toronto: The Macmillian Company (1969). 1

•Zwicky, F. & Wilson A. (eds.), New Methods of Thought and Procedure: Contributions to the Symposium on Methodologies. Berlin: Springer (1967).



Morphological Analysis and Matrix Analysis -Tools for creating new products and services

Aim of Method

- Solving problems by **splitting the problem into subproblems**
- **By combining** of found partial solutions an **overall solution** can be found
- It should be possible using this method to build a **total solution system** that contains all possible solutions in a structured format



Morphological Analysis and Matrix Analysis -Tools for creating new products and services

„Game Rules“

- You should have an idea about what you wish to do
- Define and analyze the problem/aim
- Identify the (over conceptual) attributes/parameters of the product, service or strategy you are examining
- List all possible concrete manifestations/solutions
- Combine partial solutions to an overall solution
- Reduce the number of possible solutions through the elimination of the illogical solution combinations



Morphological Analysis and Matrix Analysis -Tools for creating new products and services

Advantages

- clear structuring of the problem
- highly complex tasks can be clearly displayed

Disadvantages

- Confusion by diversity
- Loss of spontaneity



Attribute Listing, Morphological Analysis and Matrix Analysis

Tools for creating new products and services

Simple Example

How can this basic product be changed?



© www.ClgProject.info

 You should have an idea about what you wish to do!
Define and analyze the problem/aim!



Attribute Listing, Morphological Analysis and Matrix Analysis

Tools for creating new products and services



Identify the (over conceptual) attributes/parameters/functions of the product, service or strategy you are examining

Attributes/
Parameters/
Functions

Power Supply								
Bulb Type								
Light Intensity								
Size								
Style								
Finish								
Material								



Attribute Listing, Morphological Analysis and Matrix Analysis

Tools for creating new products and services



List all possible concrete manifestations/solutions

Attributes/
Parameters/
Functions

Solutions

Power Supply	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	...	
Bulb Type								
Light Intensity								
Size								
Style								
Finish								
Material								



Morphological Analysis and Matrix Analysis -Tools for creating new products and services

Attributes/
Parameters/
Functions

Solutions

Power Supply	Battery	Mains	Solar	Generator	Crank	Gas	Oil/Petrol	Nuclear
Bulb Type	Halogen	Bulb	LED	Colored				
Light Intensity	Low	Medium	High	Variable				
Size	Very Large	Large	Medium	Small	Hand held			
Style	Modern	Antique	Roman	Art Nouveau	Industrial	Ethnic		
Finish	Black	White	Metallic	Terracotta	Enamel	Natural	Fabric	
Material	Metal	Ceramic	Concrete	Bone	Glass	Wood	Stone	Plastic

Morphological Analysis and Matrix Analysis -Tools for creating new products and services

- Combine partial solutions to an overall solution
- Eliminate the illogical solution combinations

Attributes/ Parameters

Solutions

Power Supply	Battery	Mains	Solar	Generator	Crank	Gas	Oil/Petrol	Nuclear
Bulb Type	Halogen	Bulb	LED	Colored	Wick			
Light Intensity	Low	Medium	High	Variable				
Size	Very Large	Large	Medium	Small	Hand Held			
Style	Modern	Antique	Roman	Art Nouveau	Industrial	Ethnic		
Color	Black	White	Metallic	Terracotta	Enamel	Natural	Fabric	
Material	Metal	Ceramic	Concrete	Bone	Glass	Wood	Stone	



Concept 1



Concept 2



Concept 3



Attribute Listing, Morphological Analysis and Matrix Analysis

Tools for creating new products and services

How to evaluate the concepts?

Theoretically possible combinations:
 $N = 8 * 4 * 4 * 5 * 6 * 7 * 8 = 215040$



Concept 1



Concept 2



Concept 3

Morphological Analysis and Matrix Analysis -Tools for creating new products and services

How to evaluate the concepts?

1. Define some criteria for evaluation: e.g.

- | | |
|--------------------------------|--|
| 1. Low production costs: | 0 points... pc high
2 points... pc middle
4 points... pc low |
| 2. Functional performance: | 0 points... none
1 points... perhaps
4 points... probably |
| 3. Robustness of construction: | 0 points... perhaps
4 points... probably |

Morphological Analysis and Matrix Analysis -Tools for creating new products and services

0=Zeile weniger wichtig als Spalte

1=Zeile gleich wichtig wie Spalte

2=Zeile wichtiger als Spalte

How to evaluate the concepts?

2. Compare the criteria to find out how important they are.

0= Line is less important than column

1= Line as important as column

2= Line more important than column

criteria for the lamp concepts	1 Low production costs:	2 Functional performance	3 Robustness of construction	4	5	6	Importance absolute	Importance relative
1 Low production costs:		2	2	1	2	2	9	33%
2 Functional performance	0		1	1	0	1	3	11%
3 Robustness of construction	0	0		1	0	1	1	4%
4	1	1	1		1	1	4	15%
5	0	2	2	1		2	5	19%
6	0	1	1	1	0		5	19%
Summe							27	100%

Morphological Analysis and Matrix Analysis -Tools for creating new products and services

concepts for lamps ...

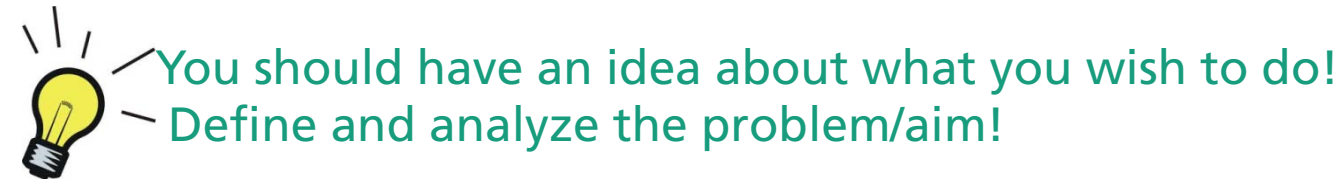
Nr.:	1	2	3
concepts			

Nr.	criteria	legend	Importance			
1	Production costs	0 points... pc high 2 points... pc middle 4 points... pc low	33%	2,0	0,0	4,0
2	Functional performance	0 points... none 1 points... perhaps 4 points... probably	11%	1,0	1,0	4,0
3	Robustness of construction	0 points... perhaps 4 points... probably	4%	0,0	0,0	4,0
4	criteria 4	0 ... 2 ... 4	15%	2,0	0,0	4,0
5	criteria 5		19%	2,0	1,0	3,0
6	criteria 6		19%	2,0	2,0	0,0
Sum:				1,83	0,68	3,09

Ranking (1=best solution)		2	3	1
---------------------------	--	---	---	---



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - **Transfer to rehab design**



You should have an idea about what you wish to do!
Define and analyze the problem/aim!

Idea

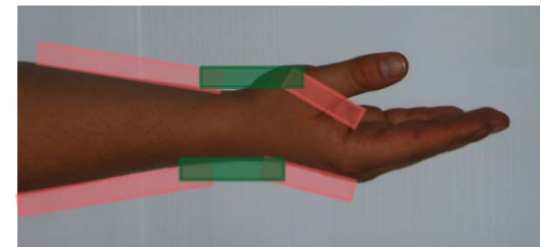
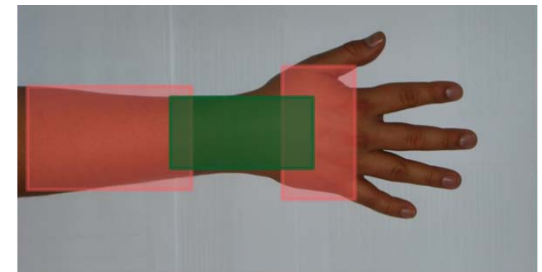
- damping tremor movement in patients with **Parkinson's** disease
- additional **orthotic device**
- support of patient's daily life activities



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - **Transfer to rehab design**

Construction elements

- 3 Modules: forearm fixation, damping element, hand fixation
- small size, little weight
- little limitation of hand's range of motion

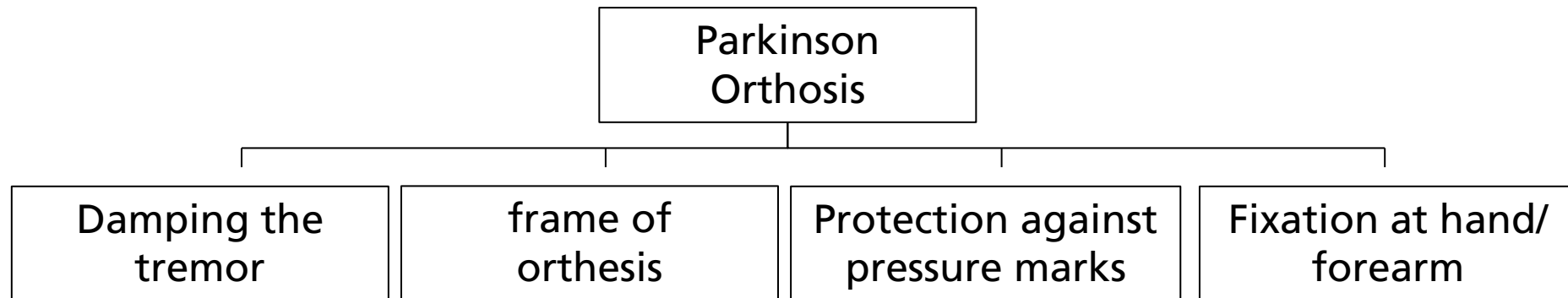


Morphological Analysis and Matrix Analysis -Tools for creating new products and services - **Transfer to rehab design**

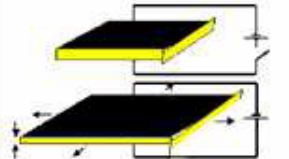


Identify the (over conceptual) attributes/parameters of the product, service or strategy you are examining

1. Identifying of 4 parameters / functions of the product



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - possibilities for damping tremor

				
Feder-Dämpfer-System	Elektromyografie + el. Signal	Elektorrheologischer Dämpfer	Schwungmassen	Seilzug + fluidische Muskeln
				
Pneumatischer Dämpfer	Kurvenscheibe + Stab (Gegenschwinger)	Force-feedback Aktoren	Versteifung	Seilzug+ Elektromotor
				
Hydraulischer Dämpfer	Magnetorheologische Elastomere	Dielektrische Elastomere	Piezokeramiken	Elektrischer Spindelantrieb + Seilzug (DOHELIX-Muskeln)
				
Magnetorheologischer Dämpfer	Formgedächtnislegierung	Torsionsstab	Carbon-Nanotube-Komposite	magneto-/elektorrheologisches Gelenk



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - possibilities for frame of orthosis



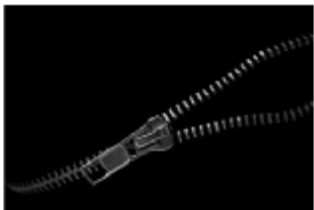


Morphological Analysis and Matrix Analysis -Tools for creating new products and services - possibilities for protection against pressure marks





Morphological Analysis and Matrix Analysis -Tools for creating new products and services - possibilities for Fixation at hand/ forearm

			
Klettverschluss	Klebeband	Rasten	Sehne
			
Knöpfe	Kabelbinder	Reisverschluss	Druckknöpfe

Morphological Analysis and Matrix Analysis -Tools for creating new products and services - listing of solutions



List all possible concrete manifestations/solutions

	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	Solution 7	Solution 8
Damping the tremor	Pneumatic damper	balance oscillator	EMG	Oscillating mass	wire rope	Force feedback	Stiffener	Hydraulic damper
frame of orthosis	cloth bandage	plastic bandage	metal bandage	bandage (neoprene, Lycra, PCM,...)	carbon bandage	fibre glass bandage		
Protection against pressure marks	cotton padding	plastic padding	gel padding	silicon padding	air-pressure padding	leather padding	synthetic leather padding	
Fixation at hand/ forearm	hook-and-loop fastener	catch fixation	cord	button	zipper	press buttons		

Morphological Analysis and Matrix Analysis -Tools for creating new products and services - combining of solutions



Combine partial solutions to an overall solution

Eliminate the illogical solution combinations

	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	Solution 7	Solution 8
Damping the tremor	Pneumatic damper	balance oscillator	EMG	Oscillating mass	wire rope	Force feedback	Stiffener	Hydraulic damper
frame of orthosis	cloth bandage	plastic bandage	metal bandage	bandage (neoprene, Lycra, PCM,...)	carbon bandage	fibre glass bandage		
Protection against pressure marks	cotton padding	plastic padding	gel padding	silicon padding	air-pressure padding	leather padding	synthetic leather padding	
Fixation at hand/ forearm	hook-and-loop fastener	catch fixation	cord	button	zipper	press buttons		

Concept 1

Concept 2



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - finding overall concepts

	concept 1	concept 2	concept 3	concept 4	concept 5	concept 6
Damping the tremor	el.Myographie+ el.Signal	Dämpfer	Dämpfer	Seilzug	Gegenschwinger	Force-feedback Aktoren
frame of orthosis	Stoffbandage	Stoffbandage	Kunststoffschiene	Fiberglasschiene	Kunststoff-schiene	Fiberglasschiene
Protection against pressure marks	Stoffauflage-flächen	Stoffauflage-flächen	Kunststoff-polsterung	Gel-Polsterung	Kunststoff-polsterung	Stoffauflage-flächen
Fixation at hand/ forearm	Klettverschluss	Klettverschluss	Reisverschluss	Klettverschluss	Rasten	Klettverschluss



Morphological Analysis and Matrix Analysis -Tools for creating new products and services - ranking of criteria

Criteria for Parkinson Orthosis Concepts	little size	light weight	cleaning	usability	comfort	free mobility	Importance absolute	Importance relative
little size		0	2	1	0	1	3	9%
light weight	2		2	1	0	1	5	14%
cleaning	2	1		1	2	2	6	17%
usability	1	1	2		0	2	4	11%
comfort	2	2	2	2		2	8	23%
free mobility	2	1	1	2	1		9	26%
Summe							35	100%

0= Line is less important than column

1= Line as important as column

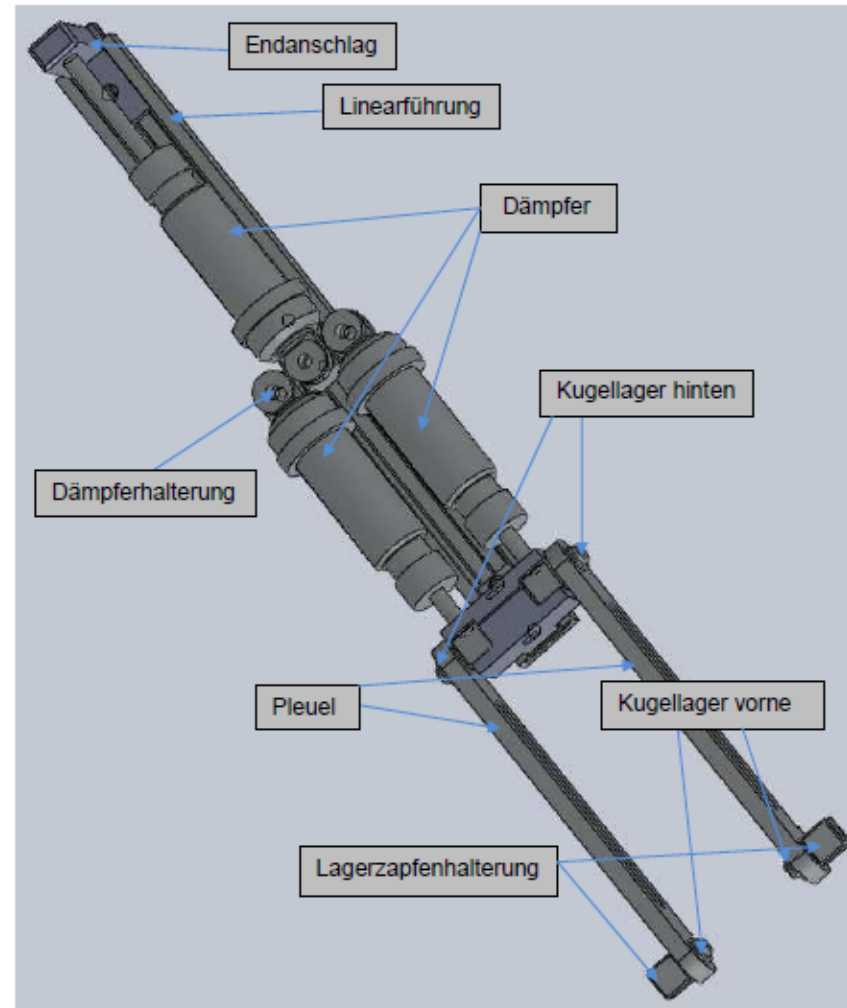
2= Line more important than column

Morphological Analysis and Matrix Analysis -Tools for creating new products and services - evaluation of concepts

			Nr.:	1	2	3	4	
	Criteria for Parkinson Orthosis Concepts		concepts	-el.Myographie+ el.Signal -Stoffbandage -Stoffauflageflächen -Klettverschluss	-Dämpfer -Stoffbandage -Stoffauflageflächen -Klettverschluss	-Dämpfer -Kunststoffschiene -Kunststoffpolsterung -Reisverschluss	-Seilzug -Fiberglaasschiene -Gel-Polsterung -Klettverschluss	-Gegenschwin -Kunststoffschiene -Kunststoffpolsterung -Rasten
Nr.	criteria	Legend	Importance					
1	little size	0 ... großer Bauraum 2 ... mittlerer Bauraum 4 ... geringer Bauraum	9%	4,0	2,0	2,0	2,0	
		Erklärung						
2	light weight	0 ... Gewicht hoch 2 ... Gewicht Vertretbar 4 ... Gewicht gering	14%	4,0	4,0	2,0	2,0	
		Erklärung						
3	cleaning	0 ... gut reinigbar 2 ... bedingt reinigbar 4 ... schlecht reinigbar	17%	4,0	4,0	2,0	2,0	
		Erklärung						
4	usability	0 ... sehr umständlich zu benutzen 2 ... Teilweise umständlich zu benutzen 4 ... sehr einfach zu benutzen	11%	2,0	4,0	4,0	2,0	
		Erklärung						
5	comfort	0 ... niedriger Tragekomfort 2 ... Tragekomfort 4 ... Hoher Tragekomfort	23%	4,0	2,0	2,0	2,0	
		Erklärung						
6	free mobility	0 ... niedrige BF 2 ... ausreichende BF 4 ... hohe BF	26%	4,0	2,0	2,0	2,0	
		Erklärung						
Detaillierung								
			Summe:	3,77	2,86	2,23	2,00	
	Ranking (1=beste Lösung)			1	2	4	5	

Ranking of concepts

Morphological Analysis and Matrix Analysis -Tools for creating new products and services - Designing Prototype Parkinson Orthosis





Attribute Listing, Morphological Analysis and Matrix Analysis Tools for creating new products and services

Prototype Parkinson Orthosis



Summary

- Morphological Analysis and Matrix Analysis are useful techniques for making new combinations of products, services and strategies – and is a very good instrument in the beginning of rehab design!

Thank you
and
Good luck
in Morphology Matrices!

Biomechanics



Dr. rer.nat. MBA Oliver Schwarz

Core competences of the group

- Bionics in orthopedics
- Kinematics for natural and adaptive motion sequences
- Testing for prosthetics & orthotics
- Human motion analysis
- Polymeric orthopedic implants

„Our goal is to develop solutions for energy-efficient motion in the field of prosthetics, orthotics and rehabilitation. “