Volumetric Approach for Determining Emissions of kg CO_2 eq. and Energy to Production of Power Tools in the Early Design Phase of the Product Life Cycle

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Seminar: Thesis Proposal to State Doctoral Exam
15th February 2017

Institute of Machine and Industrial Design

Content

- Introduction
- Current State of Knowledge
- Motivation
- The Aim of PHD Thesis
- Methodology
- Results
- Problems
- Projects
- Publication

(dreamtime.com)

Evolution of the PHD Thesis (Theme)

Brno Design

(2015)

Volumetric Methodology for Determinig CO_2 Footprint in the Industrial Design

(2016)

Volumetric Approach for Determining Emissions of kg CO_2 eq. and Energy to Production of Power Tools in the Early Design Phase of the Product Life Cycle

Evolution of the PHD Thesis (Personal Changes)

Mentor

doc. Ing. arch. Jan Rajlich

(2015)

doc. akad. soch. Ladislav Křenek, ArtD.

Mentor Specialist

(2015)

Ing. Marie Tichá

Implementation of the Standard ISO 14044 to ČSN, (LCA)

Current State of Knowledge - Articles

„Investigation into the role of core industrial designers in ecodesign projects“

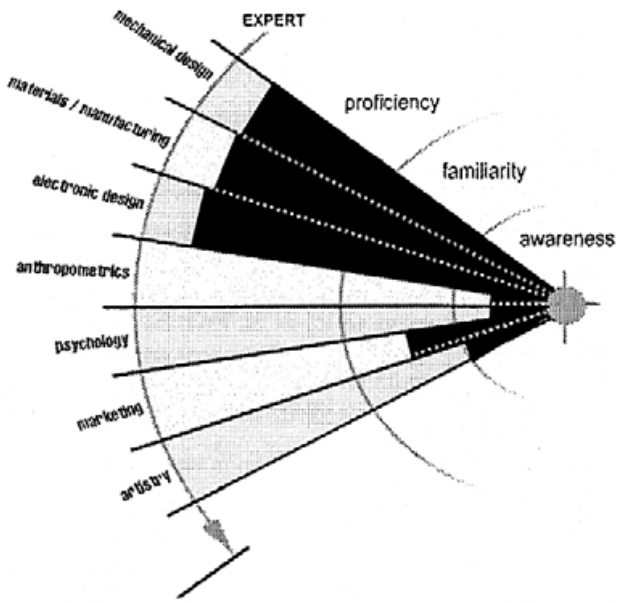


Illustration of the skills of the design engineer

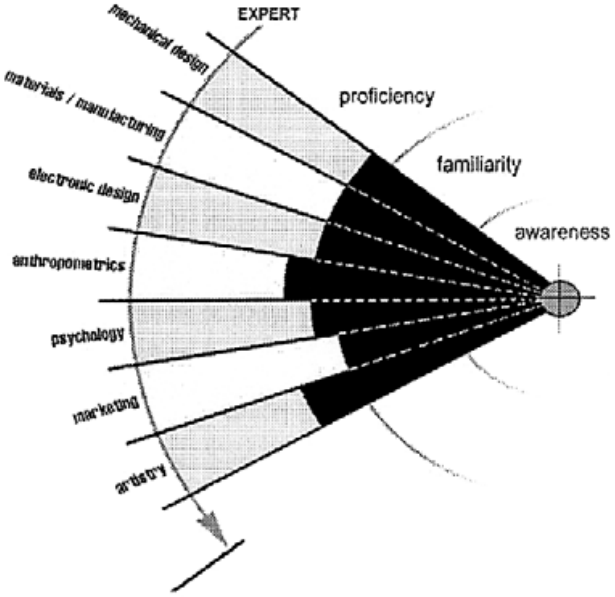


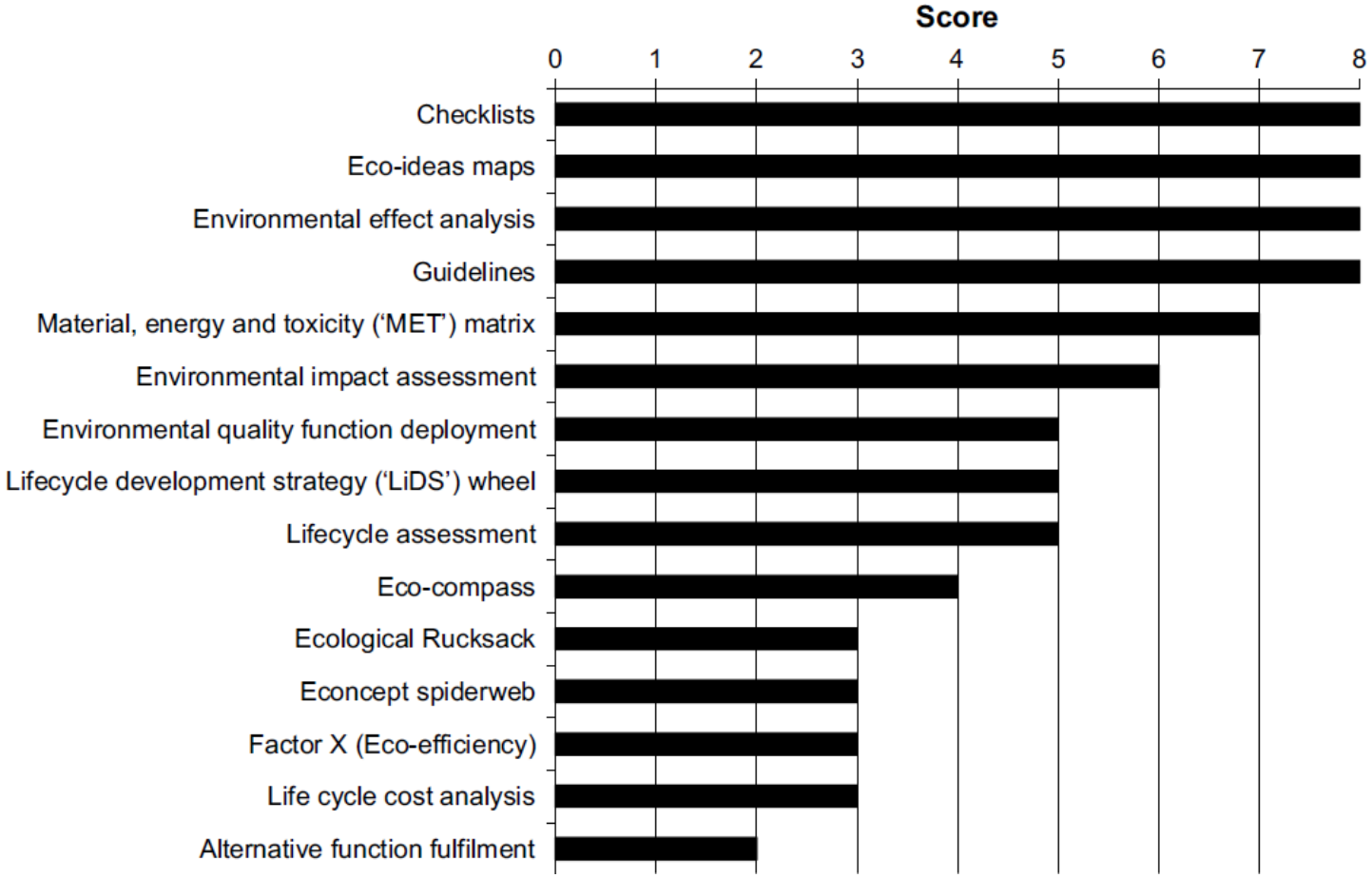
Illustration of the skills of the industrial designe

Comparison of skills between industrial designers and design engineers

(elsevier.com)

Current State of Knowledge - Articles

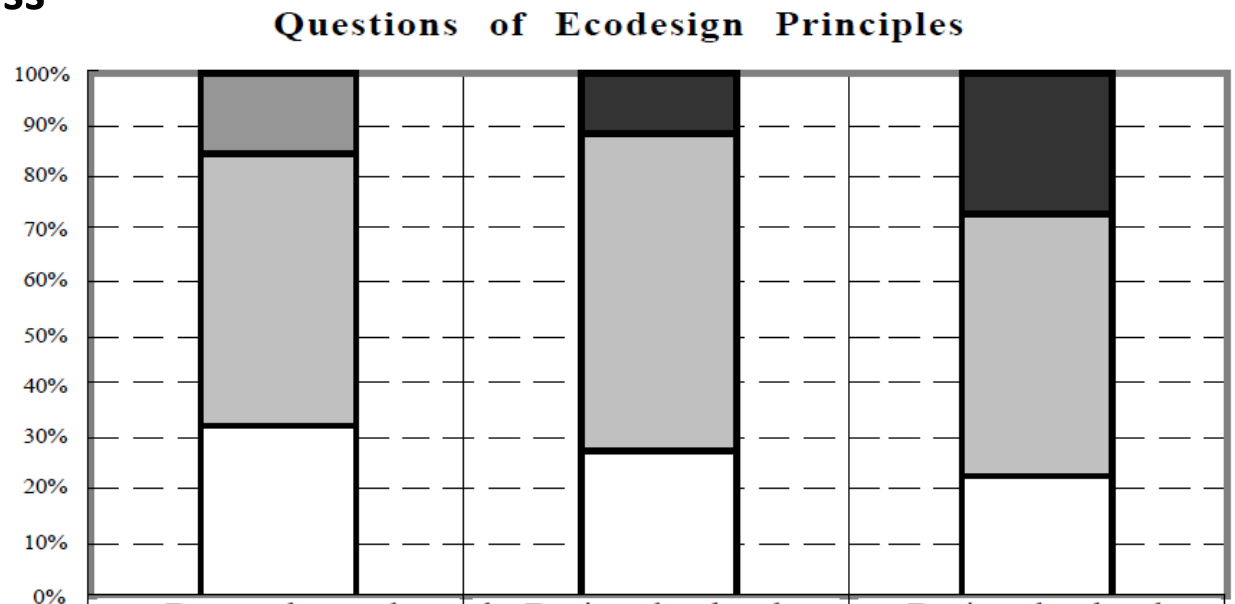
„Adopting and applying eco-design techniques: a practitioners perspective“



Analysis of identified ecodesign tools, *(elsevier.com)*

Current State of Knowledge - Articles

„The role of industrial designers in Japanese companies involved in eco-redesign process“



	a. Do you know the meaning of Sustainable Development?	b. During the develop. stage of product do you use the ISO 14001?	c. During the develop. stage of product do you use the LCA?
Not answer	16%	0%	0%
I don't know	0%	11%	27%
No	51%	61%	50%
Yes	33%	28%	23%

The knowledge about ecodesign principles, *(elsevier.com)*

Current State of Knowledge - Articles

„Environmental assessment - Gotten across to industrial designers“

1 *Oil Point (OP)* = Content of the Energy 1 *kg Oil* = 45 *MJ*

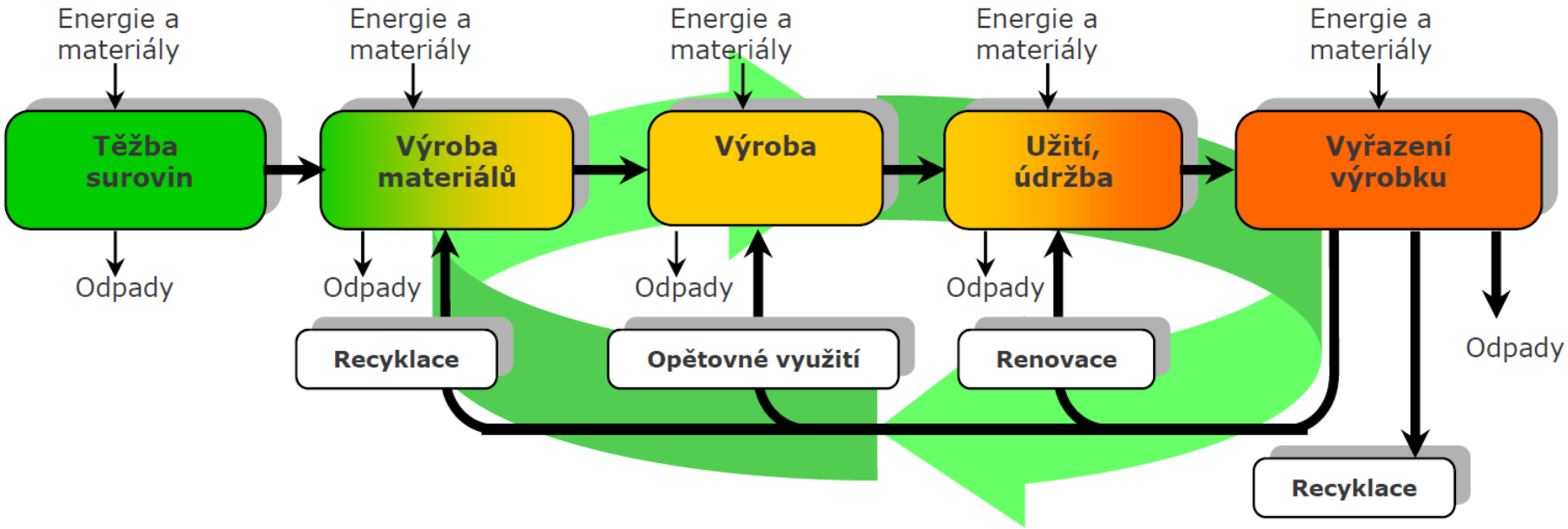
Material or process	Value	Unit
Carbon steels	1	OP/kg
Aluminium (100% primary)	4.4	OP/kg
Aluminium (100% recycled)	0.2	OP/kg
HDPE plastic (material and processing)	1.8	OP/kg
Wood, all kinds	0.5	OP/kg
Electricity (European average)	0.25	OP/kWh

The energy indicators for materials and process (OPM Method)
(designsociety.org)

Current State of Knowledge - Tools

Life Cycle Asessment (LCA)

LCA, OPM, MET matrix, LiDS wheel, ABC, KEPI, SpiderWeb



Scheme of LCA , *(cir.cz)*

Analysis of Curent State of Knowledge

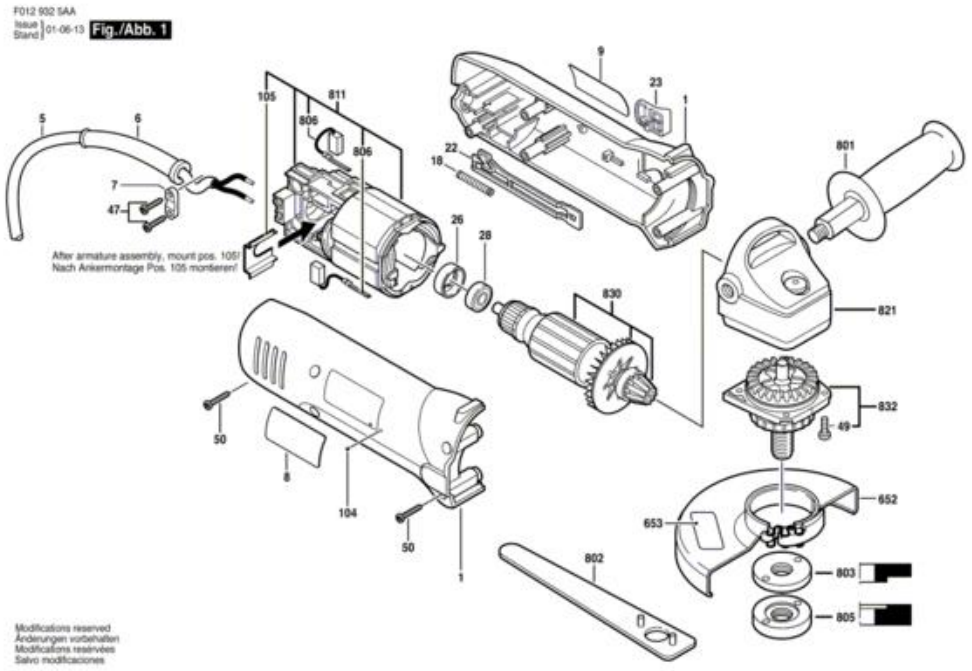
- Industrial designers are not interested about ecodesign tools
- Industrial designers not known ecodesign tools
- Implementation ecodesign tool is very expensive
- Ecodesign tools are based on LCA
- Difference between new and recycled product generated 50 % less emission

Environmental aspects, *(ecorfid.es)*

The Aim of PHD Thesis

The aim of the thesis is to develop new approach for the determination of emissions kg of CO_2 eqv. and energy inputs in the early design stage of products using their volume.

- Volumetric approach
- Easy for use
- Open for other tools
- Numerical output for design
- Energy universal approach
- Kg CO_2 eqv. (GWP100)



Section view – Angle Grinder, *(partswarehouse.com)*

Description of Process

- Definition of the product class
- Analysis of selected products
- LCI of products
- OPM & LCA analysis
- Compare data

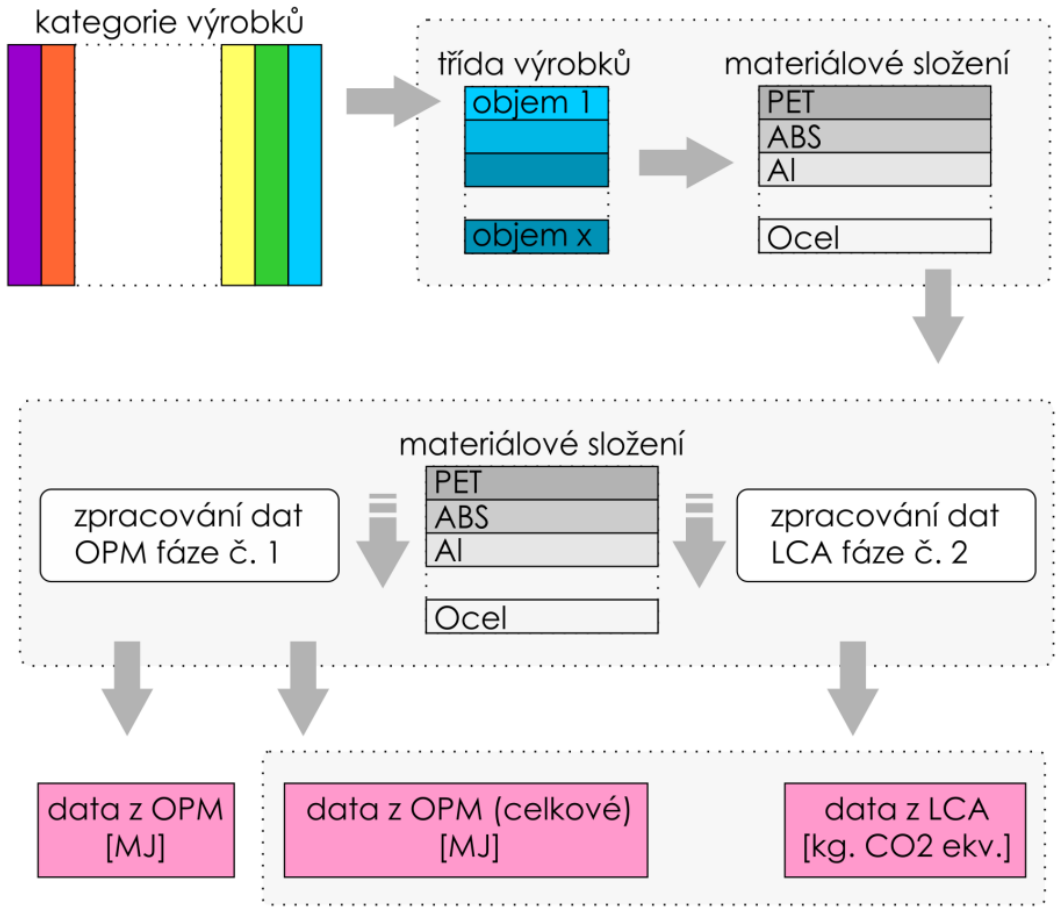
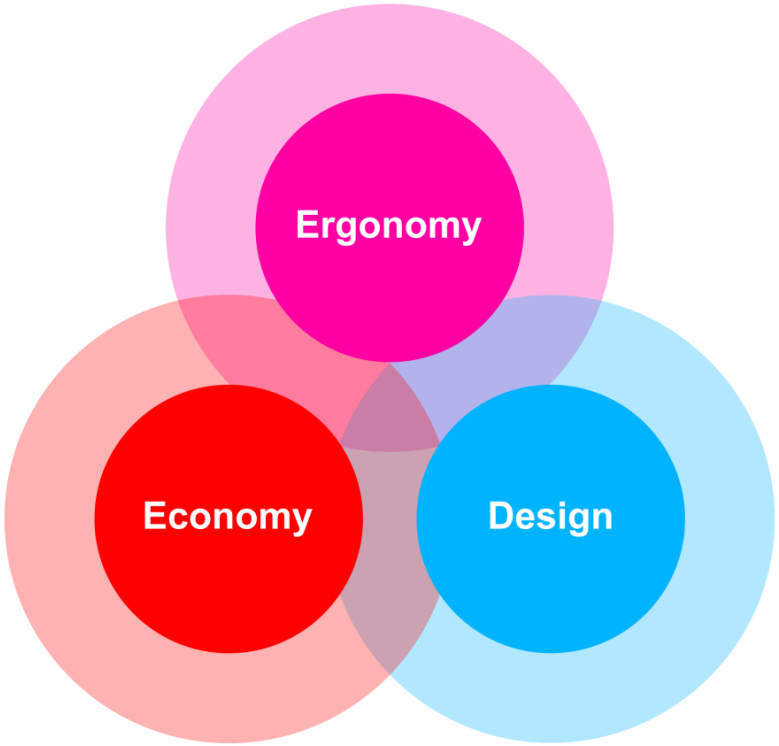


Diagram of designed methodology

Methodology

Premise

- Mutual influence (Design, Ergonomy, Economy)
- Functionaly
- Cost
- Safety
- User phase



DEE - triangular links (Design, Ergonomy, Economy)

Definition of User phase

- 3 hours non-stop in the daytime
- 52 weeks,
- 3 years

Results

Angel Grinder, disc size (115, 125, 230) mm

Table of researched power tools

Bruska průměr kotouče	Název a model brusky	Objem výrobku [ml]	Spotřebovaná energie v rámci uživatelské fáze [kWh]
115 mm	Einhell BWS 115/3	1417	1170
125 mm	Narex BU-13	1771	1872
230 mm	Einhell WS-230-4	3527	4680

Results

Type of the Obtained Results

- Energy input for manufacturing power tools

[MJ]

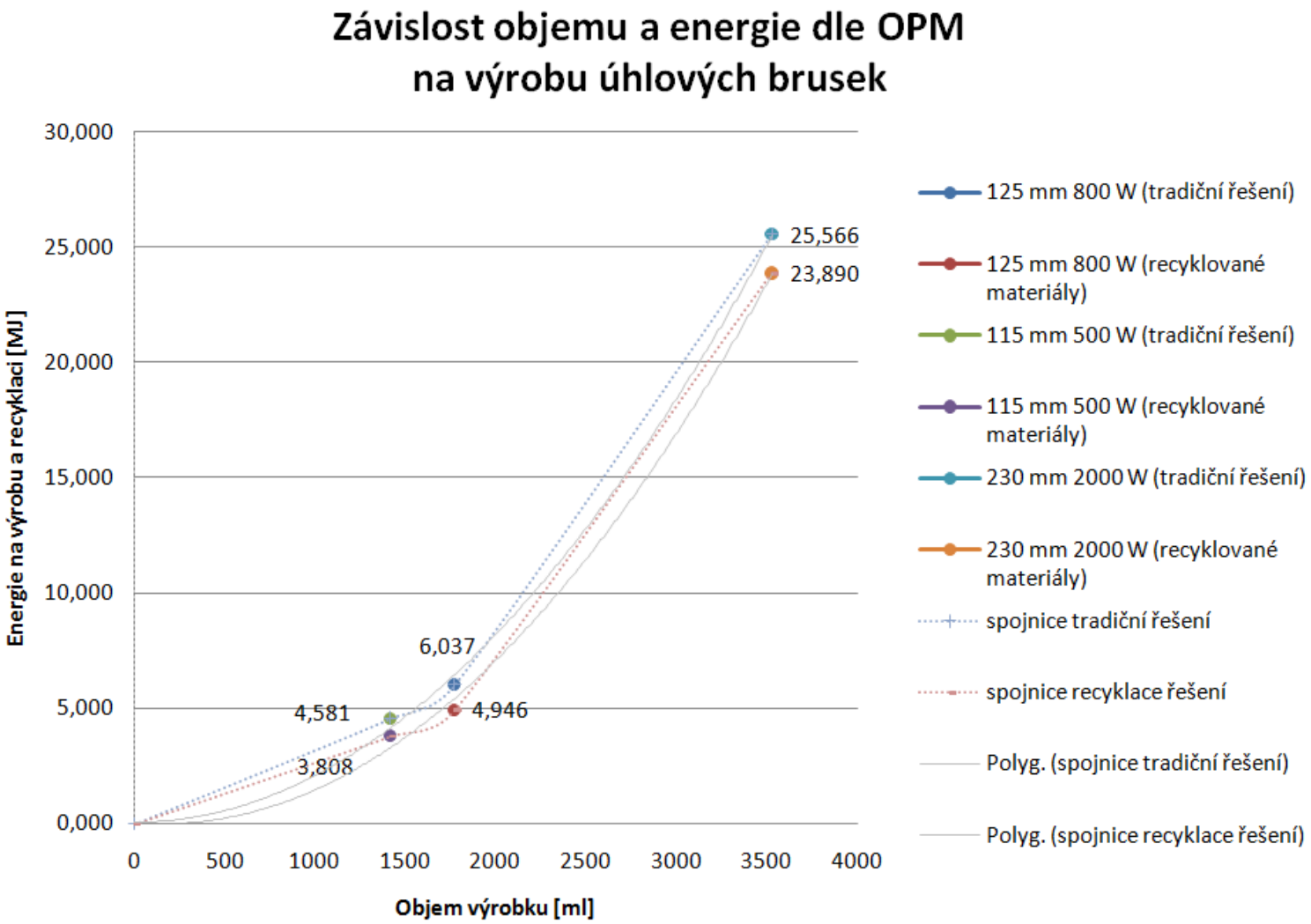
- Energy input for manufacturing power tools with recycled materials

[MJ]

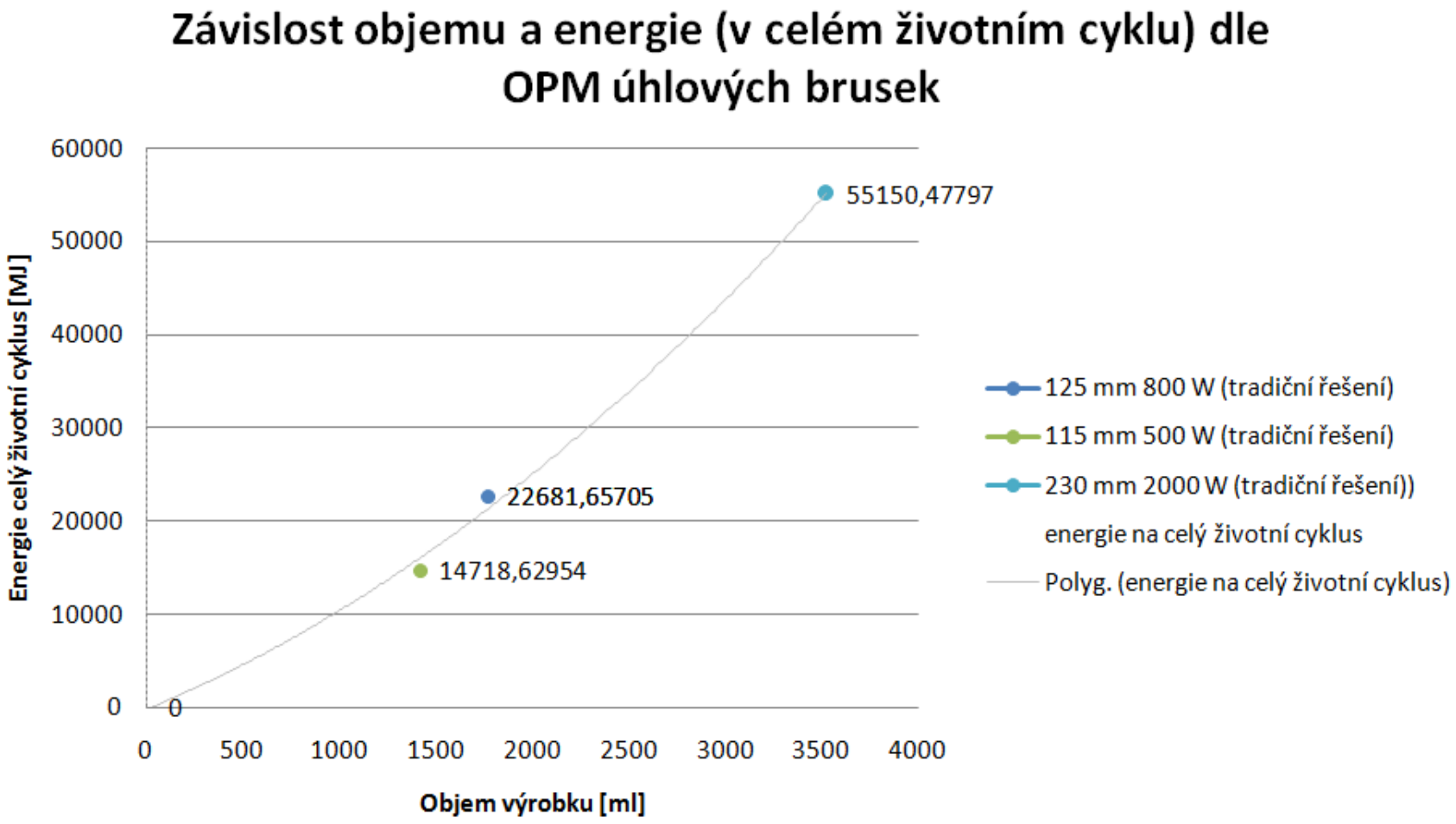
- Emission of kg CO_2 eqv. for manufacturing power tools without recyclation

[kg CO2 eqv.]

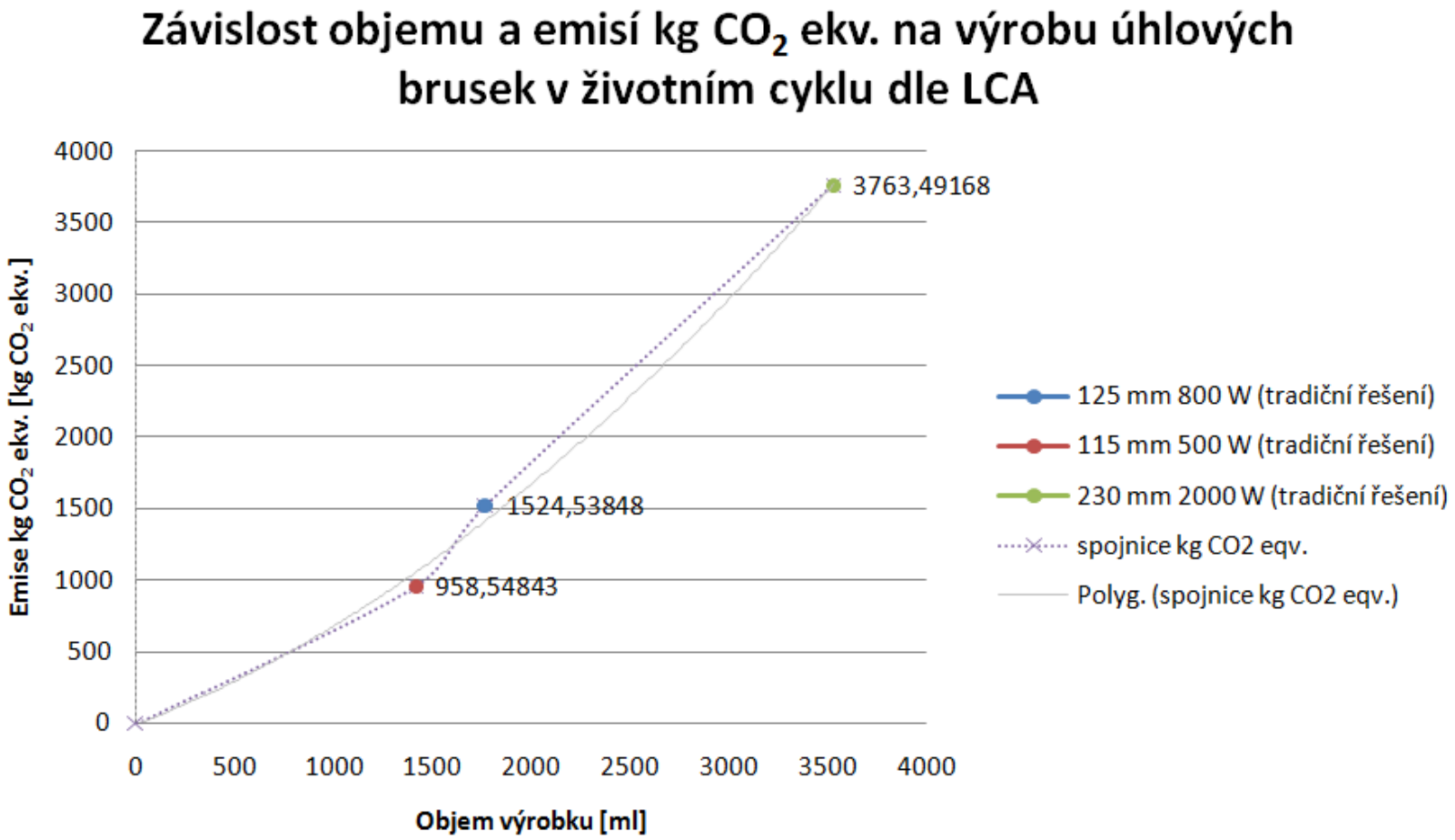
Results


Závislost objemu a energie dle OPM
na výrobu úhlových brusek
Energie na výrobu a recyklaci [MJ]
30,000
25,000
20,000
15,000
10,000
5,000
0,000
0
500
1000
1500
2000
2500
3000
3500
4000
Objem výrobku [ml]
25,566
23,890
6,037
4,581
4,946
3,808
125 mm 800 W (tradiční řešení)
125 mm 800 W (recyklované materiály)
115 mm 500 W (tradiční řešení)
115 mm 500 W (recyklované materiály)
230 mm 2000 W (tradiční řešení)
230 mm 2000 W (recyklované materiály)
spojnice tradiční řešení
spojnice recyklace řešení
Polyg. (spojnice tradiční řešení)
Polyg. (spojnice recyklace řešení)

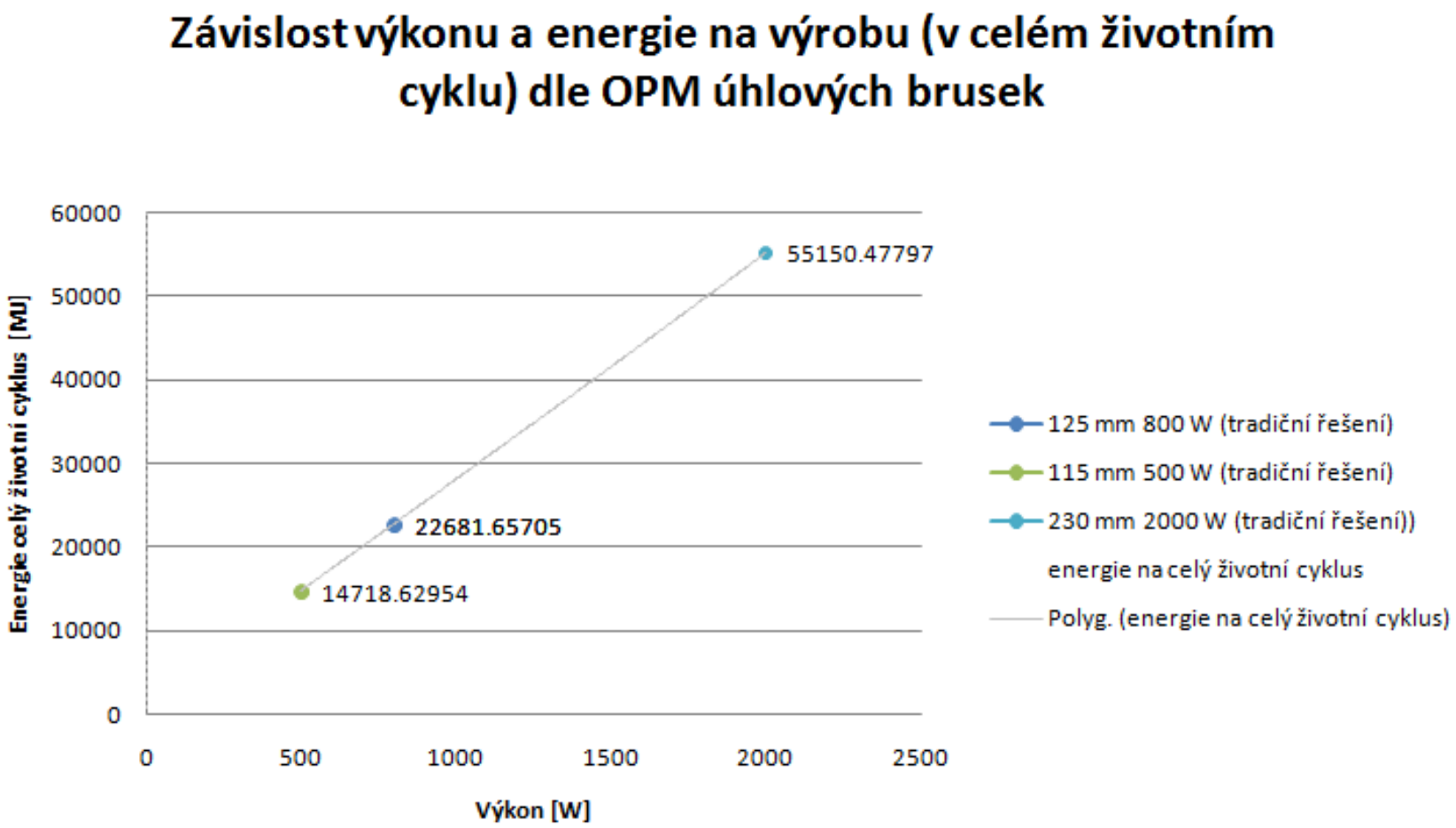
Results


Závislost objemu a energie (v celém životním cyklu) dle OPM úhlových brusek
Energie celý životní cyklus [MJ]
60000
50000
40000
30000
20000
10000
0
0
500
1000
1500
2000
2500
3000
3500
4000
Objem výrobku [ml]
55150,47797
22681,65705
14718,62954
0
125 mm 800 W (tradiční řešení)
115 mm 500 W (tradiční řešení)
230 mm 2000 W (tradiční řešení))
energie na celý životní cyklus
Polyg. (energie na celý životní cyklus)

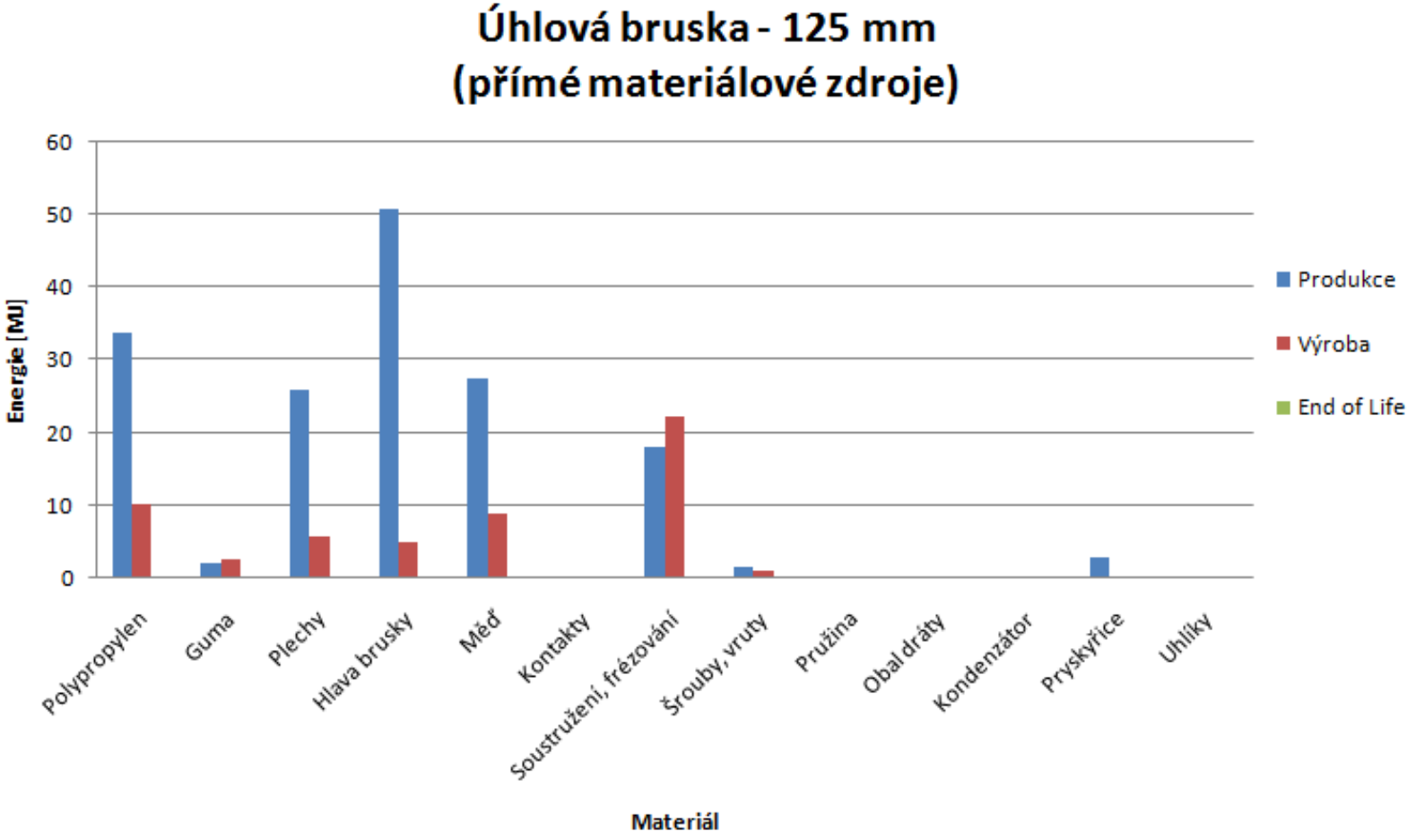
Results


Závislost objemu a emisí kg CO_2 ekv. na výrobu úhlových brusek v životním cyklu dle LCA
Emise kg CO_2 ekv. [kg CO_2 ekv.]
4000
3500
3000
2500
2000
1500
1000
500
0
0
500
1000
1500
2000
2500
3000
3500
4000
Objem výrobku [ml]
3763,49168
1524,53848
958,54843
125 mm 800 W (tradiční řešení)
115 mm 500 W (tradiční řešení)
230 mm 2000 W (tradiční řešení)
spojnice kg CO2 eqv.
Polyg. (spojnice kg CO2 eqv.)

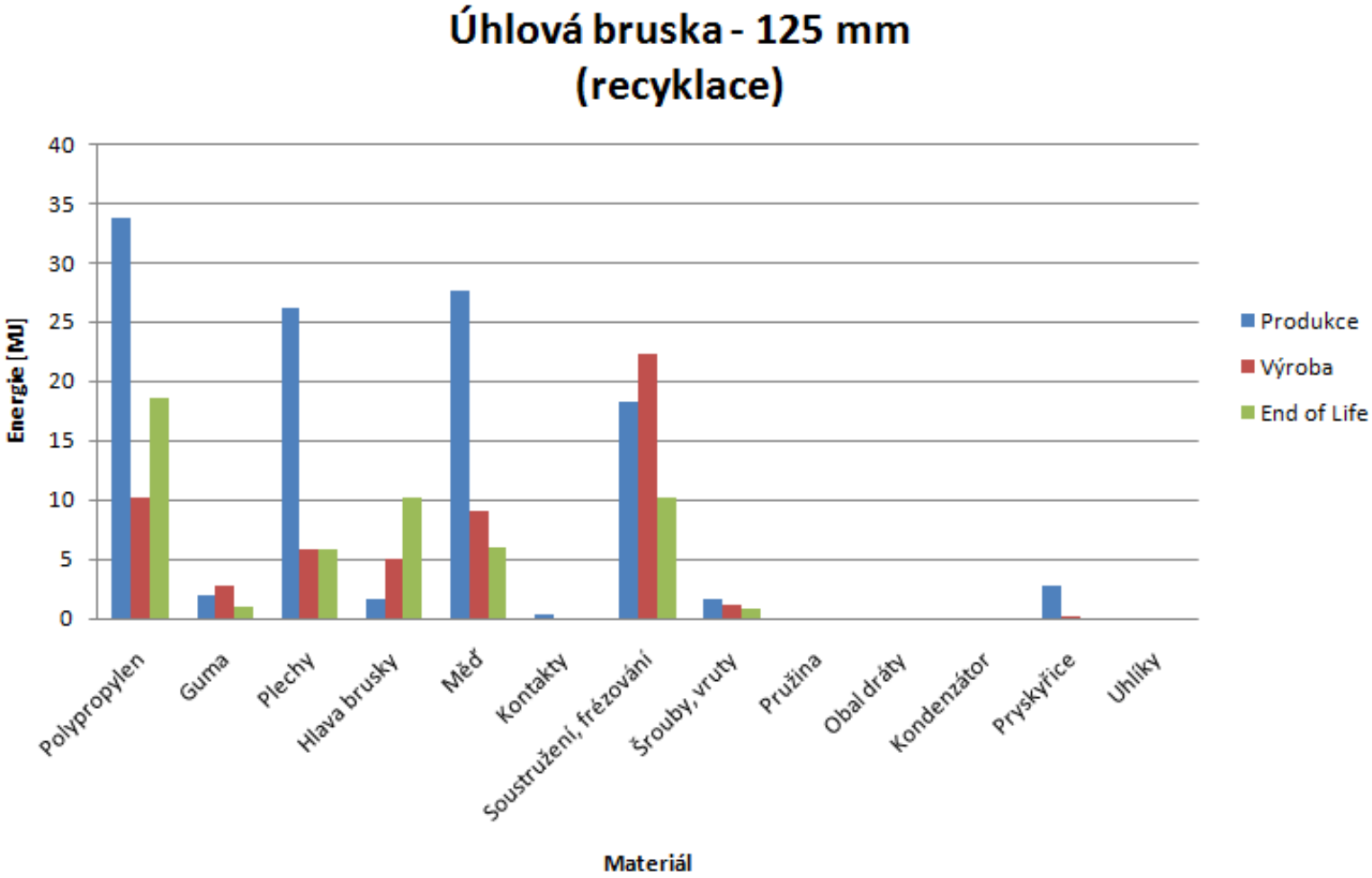
Results


Závislost výkonu a energie na výrobu (v celém životním cyklu) dle OPM úhlových brusek
Energie celý životní cyklus [MJ]
60000
50000
40000
30000
20000
10000
0
0
500
1000
1500
2000
2500
Výkon [W]
55150.47797
22681.65705
14718.62954
125 mm 800 W (tradiční řešení)
115 mm 500 W (tradiční řešení)
230 mm 2000 W (tradiční řešení))
energie na celý životní cyklus
Polyg. (energie na celý životní cyklus)

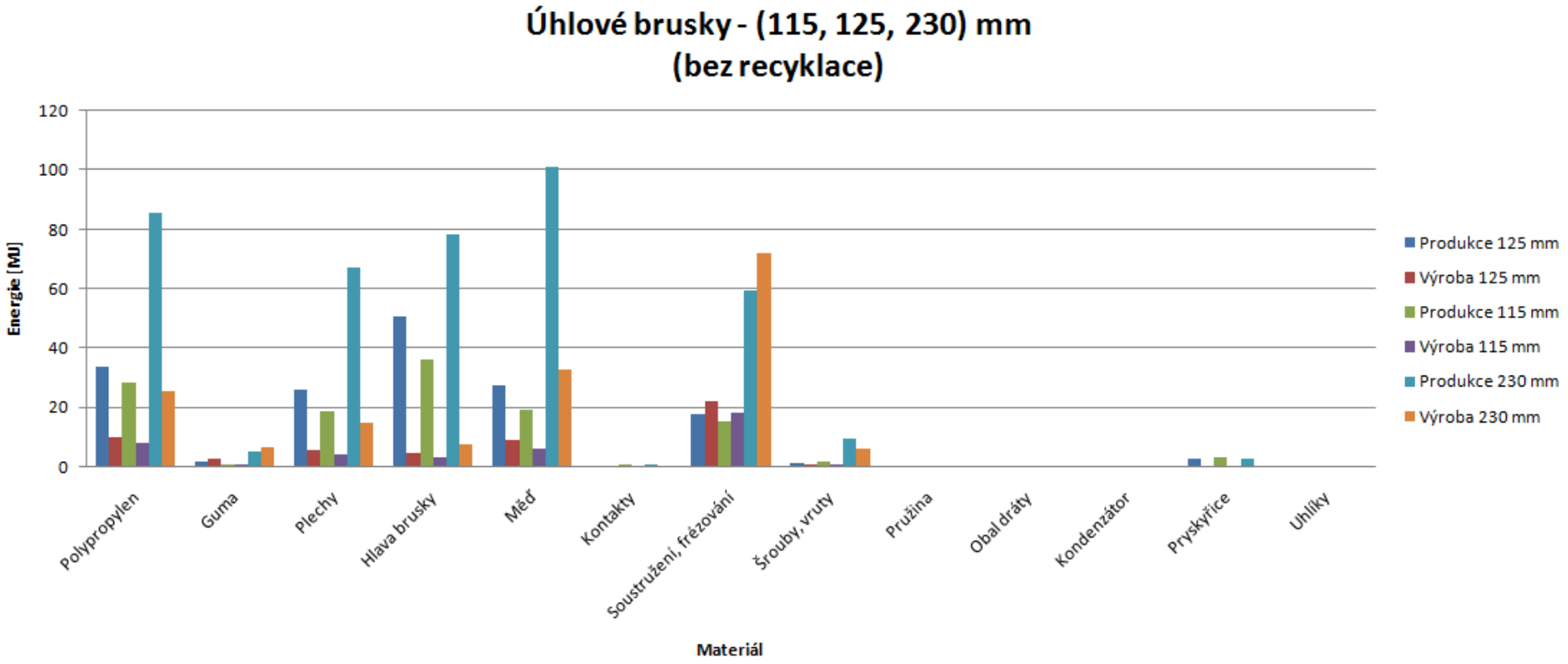
Results


Úhlová bruska - 125 mm
(přímé materiálové zdroje)
Energie [MJ]
60
50
40
30
20
10
0
Polypropylen
Guma
Plechy
Hlava brusky
Měď
Kontakty
Soustružení, frézování
Šrouby, vruty
Pružina
Obal dráty
Kondenzátor
Pryskyřice
Uhlíky
Materiál
Produkce
Výroba
End of Life

Results


Úhlová bruska - 125 mm
(recyklace)
Energie [MJ]
40
35
30
25
20
15
10
5
0
Polypropylen
Guma
Plechy
Hlava brusky
Měď
Kontakty
Soustružení, frézování
Šrouby, vruty
Pružina
Obal dráty
Kondenzátor
Pryskyřice
Uhlíky
Materiál
Produkce
Výroba
End of Life

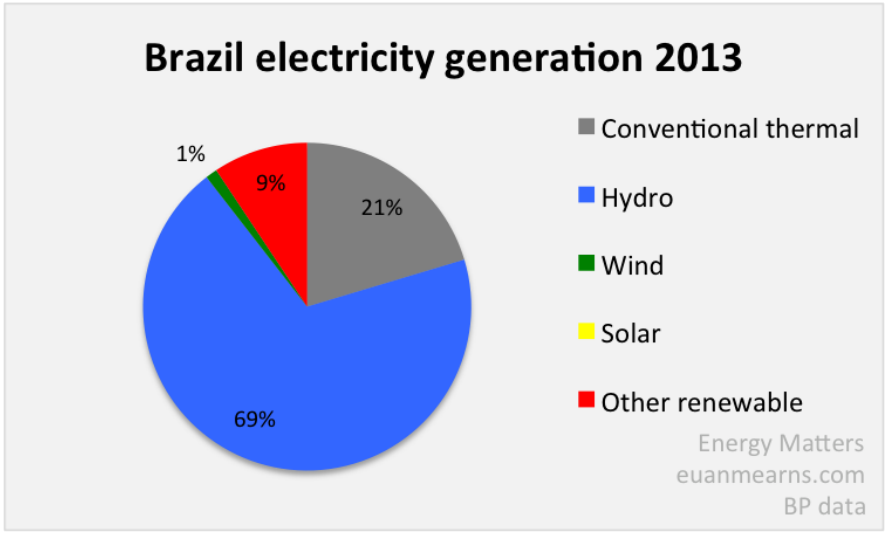
Results

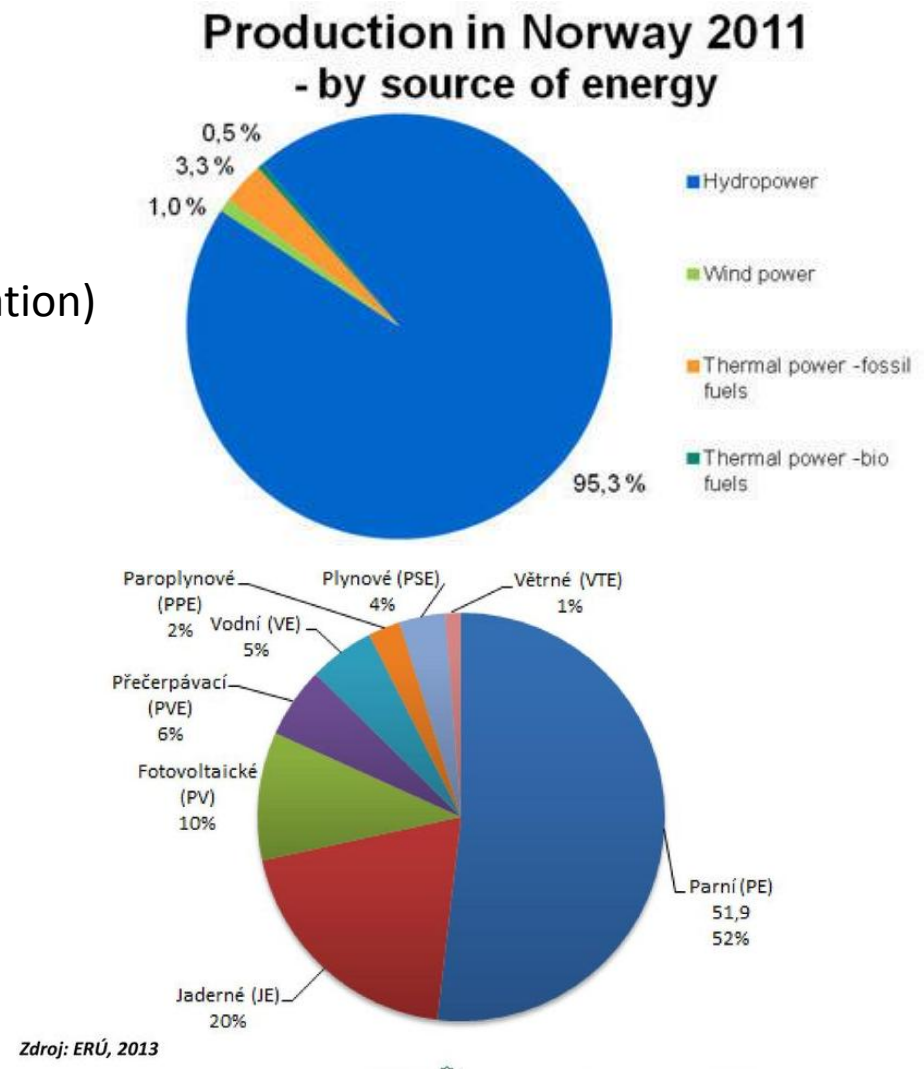

Úhlové brusky - (115, 125, 230) mm
(bez recyklace)
Energie [MJ]
120
100
80
60
40
20
0
Polypropylen
Guma
Plechy
Hlava brusky
Měď
Kontakty
Soustružení, frézování
Šrouby, vruty
Pružina
Obal dráty
Kondenzátor
Pryskyřice
Uhlíky
Materiál
Produkce 125 mm
Výroba 125 mm
Produkce 115 mm
Výroba 115 mm
Produkce 230 mm
Výroba 230 mm

Problems

Problems by Solving PHD Thesis

- kg CO_2 eqv. only for Czech Republic
- Volume setting (New approach 3D digitalisation)





Energy Mix (BR, CZ, NO)

(euanmearns.com, eru.cz, huffingtonpost.com)

Projects

Projects (2015-2016)

FV 16-21 Materials Library at the DID (room B2/307)

FV 15-15 Stand and Scanner

Project FV FSI 2016 (FV 16-21)

- 50 examples of materials
- Non-traditional materials for design
- On-line access

Project FV FSI 2015 (FV 15-15)

- 2 scanners & 2 tablets
- Portable solution, poster guide

Publication

Publication (2017-2016)

2017

SOVJÁK, R. Studying Knowledge about Eco-design Tools at Department of Industrial Design, Brno University of Technology. *GRANT Journal,* 2017, roč. 5, č. 2, s. 72-75. ISSN: 1805-0638.

SOVJÁK, R; FRIDRICHOVÁ, E. Concepts of Machine Tools Created by Students at Department of Industrial Design, Brno University of Technology., … **(in progress)**

2016

SOVJÁK, R. Summary of Eco-Design Tools for Industrial Designers. In *Book of Proceedings of 57th International Conference of Machine Design Departments.* First. Pilsen: University of West Bohemia in Pilsen, 2016. s. 399-404. ISBN: 978-80-261-0609- 8.

SOVJÁK, R. Designing Industrial Products from Non-traditional Materials. In *Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS.* Hradec Králové: Magnanimitas, 2016. s. 1445-1454. ISBN: 978-80-87952-17-7.

SOVJÁK, R. Studying Knowledge about Eco-design Tools at Department of Industrial Design, Brno University of Technology. In *Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS.* Hradec Králové: Magnanimitas, 2016. s. 1757-1763. ISBN: 978-80-87952-17-7.

SOVJÁK, R.; FRIDRICHOVÁ, E. Application of Non- traditional Materials in Design of Machine Tools Control Panel. In *Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS.* Hradec Králové: Magnanimitas, 2016. s. 1764-1768. ISBN: 978-80-87952-17-7.

Publication

Publication (2016-2015)

2016

SOVJÁK, R. Ecodesign a jeho vliv na konstrukci výrobních strojů. Brno: Vysoké učení technické v Brně, Fakulta strojního inženýrství, 2016. 67s. Vedoucí bakalářské práce Ing. Jiří Zahálka. **(Summarises ecodesign methods for the PHD thesis)**

MALÁTKOVÁ, H.; SOVJÁK, R. Design of Children Prosthetics from Non- traditional Materials. In *Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS.* Hradec Králové: Magnanimitas, 2016. s. 1455-1461. ISBN: 978-80-87952-17-7.

ZDVIHALOVÁ, M.; SOVJÁK, R. The Possibilities of Using Ergonomic Methods in Design Practice. In *Book of Proceedings of 57th International Conference of Machine Design Departments.* First. Pilsen: University of West Bohemia in Pilsen, 2016. s. 405-410. ISBN: 978-80-261-0609-8.

2015

SOVJÁK, R.; ONDRA, M.; ZDVIHALOVÁ, M. *Method of Mock- up Scanning for Acceleration of Design Process.* Machine Design 56th International Conference of Machine Design Departments. First. Scholar' s Press, 2015. ISBN: 978-3-639-66914-5.

ZDVIHALOVÁ, M.; ONDRA, M.; SOVJÁK, R. Implementation of brand on industrial products. In *Book of Proseedings of 56th International Conference of Machine Design Departmens.* 1. Nitra, SK: Slovak University of Agriculture in Nitra, 2015. s. 266-271. ISBN: 978-80-552-1377-4.

SOVJÁK, R.; ONDRA, M.; ZDVIHALOVÁ, M. Method of Mock- up Scanning for Acceleration of Design Process. In *Book of Proceedings of 56th International Conference of Machine Design Departments.* First. Nitra: Slovak University of Agriculture in Nitra, 2015. s. 229-232. ISBN: 978-80-552-1377-4.

Thank you for attention

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