

CTC Primena VRPM tehnologija u inovativnom razvoju proizvoda **I3E**
www.i3e.eu

KOORDINATIVNI SASTANAK
Formiranje VRPM tematske grupe
(Virtual/Rapid Prototyping/Manufacturing)
4. Jul 2011, Kragujevac

Primena VRPM tehnologija u inovativnom razvoju proizvoda, sa fokusom na potrebe domaće privrede

Prof. dr Vesna Mandić, Koordinator CTC Kragujevac
mandic@kg.ac.rs

Prof. Dr Vesna Mandić

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Kooperativni Trening Centar – CTC Kragujevac
Centar za Virtuelnu Proizvodnju - CeVIP



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Realizovani medjunarodni projekti

1. TEMPUS, IMG-Individual mobility grant, Type 3 - IMG-SCG1007-2004 (Project Coordinator).
2. WUS Austria, CDP+, 2005/06, Modeling and Simulation in Metal Forming. (Project Coordinator)
3. EUREKA/ASMATA, 2005, E13240: Renewal of steel car parts with aluminium, – ASMATA
4. Bilateral project between Serbia and Slovenia, 2006/07, Optimization of material forming processes through physical modelling, FE simulation and inverse analysis. (Coordinator-Serbia)
5. eLearning WUS project, 2006, No. 002/06, Development of Metal Forming Electronic Instructional Resources (Project Coordinator).
6. Course Development Plus WUS project, 2006, Virtual Engineering (Project Coordinator)
7. Virtual Manufacturing Support for Enterprises in Serbia, EAR-EDEP Programme, 2006-2007 (Project Coordinator)
8. Reinforcement of Research Capacity in Software Development and Innovative Collaborative Design and Engineering in Serbia and Montenegro, RRCSD INNCODE, FP6 INCO 043820, 2007-2009, (Executive Project Manager)

World University Service - Austrian Committee



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Tekući međunarodni projekti

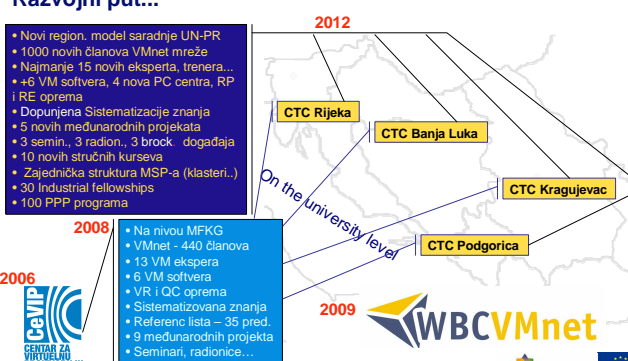
1. "WBC-VMnet"
WBC Virtual Manufacturing Network – Fostering an Integration of the Knowledge Triangle (January 2009 – January 2012)
2. "I3E"
Promoting Innovation in the Industrial Informatics & Embedded Systems Sectors through Networking (November 2009 – September 2012)
3. Bilateral project between Serbia and Croatia 2011-2012, Modelling and optimization of tool by application of information technologies of virtual manufacturing with experimental verification



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Razvojni put...



2012

- Novi region, model saradnje UN-PR
- 1000 novih članova VMnet mreže
- Najmanje 15 novih eksperata, trenera...
- +6 VM softvera, 4 nova PC centra, RP i RE oprema
- Dopunjena Sistematizacije znanja
- 5 novih međunarodnih projekata
- 3 semin., 3 radion., 3 brock. događaja
- 10 novih stručnih kurseva
- Zajednička struktura MSP-a (klasteri...)
- 30 Industrial fellowships
- 100 PPP programa

2008

- Na nivou MFKG
- VMnet - 440 članova
- 13 VM eksperata
- 6 VM softvera
- VR i QC oprema
- Sistematizovana znanja
- Referenc lista – 35 pred.
- 9 međunarodnih projekta
- Seminarsi, radionice...

2006

2009 WBCVMnet

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Mreža Kooperativnih Trening Centara u WBC regionu



Western Balkan region

Croatia, B&H, Serbia, Montenegro

Join and Benefit

Network of Collaborative Training Centres in the WBCs

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WBC - Virtual Manufacturing Network
1130 članova iz WBC regiona

Virtual Manufacturing Network - VMnet in the WBCs

VMnet statistics

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Vizija
Postati snažan kooperativni centar koji će inicirati, posredovati i održavati obostrano korisno partnerstvo između univerziteta, odnosno njegovih članica, studenata i diplomiranih, s jedne strane i preduzeća i ostalih partnera za podršku MSP sektoru, s druge strane strane.

Misija
Razviti efikasne i efektivne mehanizme za saradnju između univerziteta i preduzeća, kroz:

- realizaciju zajedničkih projekata (FP7, EUREKA, IPA, TEMPUS...),
- napredne usluge inovativnog razvoja proizvoda
- stručnih treninga za preduzeća i nezaposlene,
- Program industrijskih stipendija (Industrial Fellowship Programme) i
- Program studentske prakse (Student Practical Placement Programme)

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CTC koristi moderan pristup u integrisanom razvoju proizvoda i procesa baziran na primeni najsavremenije opreme i softvera

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Primena:
• automobilska industrija
• avio industrije i astronautika
• industrija elektrokomponenti za domaćinstvo
• analizi delova od lima koji se izrađuju u malim alatnicama...

Stampack

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simufact.forming


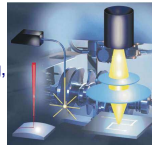
Optimizirani procesi - zajedno sa dostignutim visokim kvalitetom proizvoda - u najkraćem vremenu, su rešenje za mnoštvo izazova za korisnike, na internacionalnom konkurentskom tržištu.

Moćan "alat" u rukama stručnjaka koji se bave projektovanjem proizvoda i procesa, tehnologijom, konstrukcijom, koji vodi boljem razumevanju procesa, prevenciji defekata i otkaza u proizvodnji, poboljšanom kvalitetu proizvoda.

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Multisenzorska CMM mašina, WERTH Video-check IP250

Sensors:

- Optical (image processing, auto-focus, 3D Patch)
- Laser
- Fiber

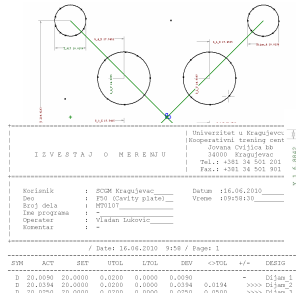
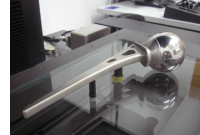
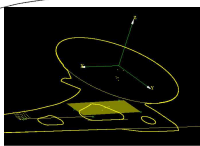
Dimensions:

- X – 250 mm
- Y – 125 mm
- Z – 250 mm

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Multisenzorska CMM mašina, WERTH Video-check IP250

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Rapid prototyping mašina (RP) - Alaris30 3D štampač





Veličina radnog stola (x,y,z): 300 x 200 x 150 mm
 Max. veličina 3D modela: 294 x 196 x 150 mm
 Debljina sloja: 28 µm
 Rezolucija (x,y,z): 600 x 600 x 900 dpi
 Materijal: VeroWhite FullCure 830
 Ulazni format fajla: STL i SLC fajl

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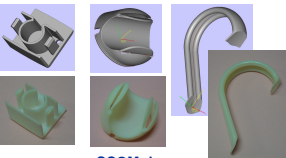

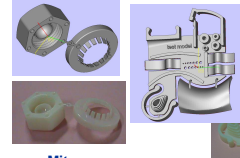



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Objekt PolyJet proces

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Virtual Reality oprema







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Ostali MFKG resursi



ATOS IIe RE system

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Ostali MFKG resursi



FARO arm platinum system

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Ostali resursi – spoljni eksperti VMnet

Usluge Centra: Center for Integrated Microsystems and Components
University of Novi Sad, Faculty of Technical Sciences

- ❖ Projektovanje složenih elektronskih kola i ugrađenih sistema, izrada studija izvodljivosti i konsalting.
- ❖ Izrada štampanih pločica i elektronskih komponenti i kola na modernoj mašini za brzu fabrikaciju prototipova na PCBu.
- ❖ Izrada elektronskih komponenti, kola i sistema (kao što su RFID tagovi, kartice, senzori, itd.) na fleksibilnoj osnovi.
- ❖ Projektovanje i izrada različitih vrsta senzora (temperature, pritiska, vlage, itd.)
- ❖ Ispitivanje, testiranje i karakterizacija različitih vrsta elektrotehničkih materijala.
- ❖ Specijalizovane obuke iz oblasti softverskih alata za simulaciju komponenti i kola kao i novih oblasti elektroni

Prof. Dr. Vesna, dr Goran Stojanović

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Ostali resursi – spoljni eksperti VMnet (Prof. Dr Goran Stojanović, FTN)

Fabrikacioni kapaciteti



Fleksibilna osnova Čvrsta osnova

Rapid Prototyping/manufacturing in microelectronics

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Virtuelni razvoj proizvoda i re-inženjering u okviru integrisanog VE (Virtual Engineering) sistema

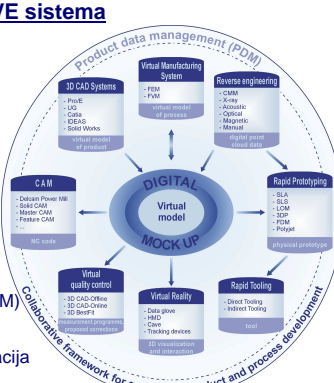



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Komponente integrisanog VE sistema

- > Virtuelni prototipovi (VP)
- > Fizički prototipovi – Rapid prototyping/manufacturing (RPM)
- > Reverzni inženjering (RE)
- > Virtuelna stvarnost (VR)
- > Virtuelna proizvodnja (VM)
- > Digital mock up (DMU)
- > Product data management (PDM)
- > Product life cycle management (PLM)
- > Collaborativno okruženje
- > Virtuelna kontrola kvaliteta i verifikacija



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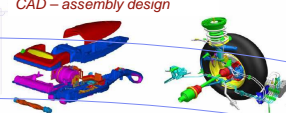
Virtual prototyping (VP)

3D CAD Systems

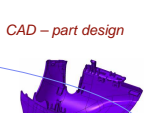
- Pro/E
- UG
- Catia
- IDEAS
- Solid Works

virtual model of product

CAD – assembly design



CAD – part design

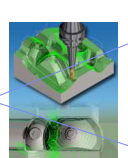
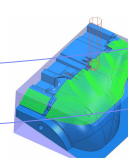
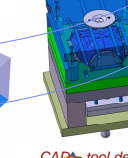


CAM

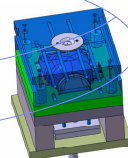
- Delcam Power Mill
- Solid CAM
- Master CAM
- Feature CAM

NC code

CAM – Machining strategy, NC programming

CAD – tool design



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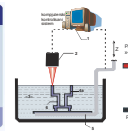
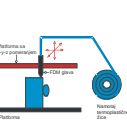
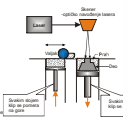
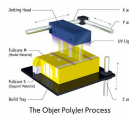
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Physical prototyping – Rapid prototyping/manufacturing (RPM)

Rapid Prototyping

- SLA
- SLS
- LOM
- 3DP
- FDM
- Polyjet



physical prototype

Rapid Tooling


- Direct Tooling
- Indirect Tooling

tool

Applications:

- Medicine;
- Electronics;
- Automotive;
- Consumers goods;
- Architecture;
- Education;
- Entertainment;
- Defence;
- Industrial machinery...



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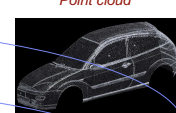
Reverse engineering (RE)

Reverse engineering

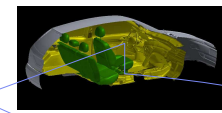
- CMM
- X-ray
- Acoustic
- Optical
- Magnetic
- Manual

digital point cloud data


Point cloud



CAD model



Optical scanning



FORD Focus

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Virtual reality (VR)

Virtual Reality

- Data glove
- HMD
- Cave
- Tracking devices

3D visualization and interaction

...generiše virtuelno okruženje u kojem je omogućena 3D prezentacija proizvoda, alata, procesa u realnom vremenu, u realnim uslovima uz interakciju sa korisnikom

Sadašnjost



Budućnost



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Virtual manufacturing (VM)

Virtual Manufacturing System

- FEM
- FVM

virtual model of process

- ❖ "proizvodnja u kompjuteru"
- ❖ nelinearna FE and FV simulacija i analiza
- ❖ izvođenje "what-if" simulacija za procenu projektnih alternativa
- ❖ omogućava optimizaciju proizvodnih procesa baziranu na *sensitivity analysis*
- ❖ optimizira ključne faktore koji utiču na profitabilnost



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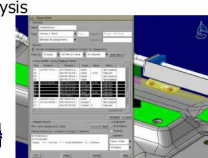
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Digital mock up (DMU)

DIGITAL Virtual model MOCK UP

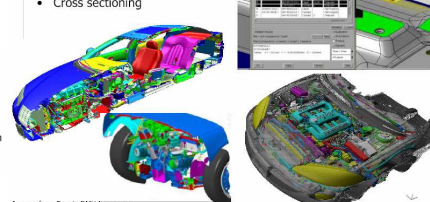
DMU – Static Space Analysis

- Clash/Contact analysis
- Minimal gap check
- Distance analysis
- Cross sectioning



DMU – Dynamic Analysis

- Collision check during motion
 - kinematics
- Explode view
 - assembly/disassembly simulation
- Swept volume analysis
 - disassembly path finding



Images from Enovia DMU Navigator

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Product data management (PDM)

Collaborative framework

The diagram illustrates a collaborative framework between four main stages: PDM, CAD, FEM, and Optimizacija.

- PDM-EDM modul** feeds into the **CAD modul**.
- CAD modul** (using STEP - IGES - Standardni CAD) feeds into the **FEM** stage.
- FEM** stage includes:
 - Pre-processor**: FEM pre-procesiranje (Meširanje, Granitni uslovi), Optimizacija pre-procesiranja (Definisanje i optimizacija zadatka).
 - Post-processor**: FEM post-procesiranje (Optimizacija post-procesiranja).
 - Post-optimizacione aktivnosti**: Iso površine, Usitnjavanje mreže, Redukcija podataka.
- Optimizacija** stage includes:
 - Optimizacioni modul**: Modul provjere, FEM solver, Optimizacija.
- Data exchange between FEM and Optimizacija involves **IZRADA PROTOTIPOVA (STL)** and **VIRTUALNA REALNOST (VRML)**.

 The process is supported by **STEP - IGES - Standardni CAD** and **IZRADA PROTOTIPOVA (STL)** / **VIRTUALNA REALNOST (VRML)**.

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Virtuelna proizvodnja u Virtualnim preduzećima (uslov je uspostavljeno Cooperativno okruženje)

Definitions of a Virtual Enterprise

- Several smaller companies that cooperate to design and manufacture a product
- A global partnership that integrates its activities via computer communication
- A large manufacturer and its supply chain
- A flexible organization that changes when new opportunities appear

Jeffrey W. Herrmann, University of Maryland

Izvor: Institute for Systems Research, University of Maryland

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Studija slučaja

Re-inženjering proizvoda:

- Reverse Engineering** – for scanning of blank shape and free surfaces of handle
- CAD modelling** – for 2D model of blank and 3D model of handle
- Virtual Manufacturing System** – for virtual verification of proposed technology and dies design
- Rapid Prototyping** – for physical verification of simulation FE model
- Quality control** – for comparison between real part and RP of simulation model
- Virtual Reality** – for 3D visualization and interaction with virtual models

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Studija slučaja

RE - optical scanning - laser scanning, Multisensor CMM Wehr

3D CAD - point cloud - CAD modeling - STL (from physical model), CATIA

VM - numerical FE simulation - optimization of preform - tool development - STL (from numerical model), Simufact forming

RP - rapid prototyping - polyjet technology, SUB3CT Alaris 3D

QC - optical scanning - laser scanning - comparison and verification, Multisensor CMM Wehr

VR - 3D visualization - interaction with virtual environment - detail inspection of virtual FE model, virtual DOT data glove - software layer - Q 3D projection - Webviewer

Sheet metal blank

Optical 2D scanning of closed contour with backlighting illumination

CAD model of blank, Point cloud

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Real part - handle

3D scanning of handle:

- Optical 3D scanning of contour shape with backlighting illumination and autofocus option
- Laser sensor for scanning of free form top surface

CAD models of tools

Point cloud

CAD model of top surface of handle

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CAD model of blank

Virtual manufacturing – FE simulations of bending and deep drawing operations of handle manufacture

Virtual tool assembly for 2nd stage

FE mesh of blank

Virtual handle

FE mesh preform

Virtual tool assembly for 1st stage, in Simufact pre-processor

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Studija slučaja

VM - numerical FE simulation
- optimization of preform
- tool development
- STL (from numerical model)

Simufact. forming

Simufact. forming FE simulations

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Studija slučaja

VM - numerical FE simulation
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Simufact. forming

Effective stress distribution

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Studija slučaja

VM - numerical FE simulation
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Simufact. forming

Prof. Dr Vesna Mandić **FE results of final forming of handle, in cross-sections 1 and 7**

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Studija slučaja

RP - rapid prototyping
- polyjet technology

OBJECT Alaris 3D

STL model from FE

RP 3D printer – ALARIS30

Rapid prototyping of virtual handle from FE model:

- PolyJet technology
- 28-micron layers, high-resolution printing
- Material: VeroWhite FullCure 830

Comparison of real metallic part and plastic RP

RP of handle

Prof. Dr Vesna Mandić

CTC **Primena VRPM tehnologija u inovativnom razvoju proizvoda** **I3E**

Studija slučaja

QC - optical scanning
- laser scanning
- comparison and verification

Multi-sensor CMM WERTH VC-IP250

RP of handle

Cross-section position

Comparison of RP-FE model and real part of handle, measurement at 8 cross-sections:

- Laser sensor - scanning

Measurement results – cross-section 4

Comparison of stamped real part and RP model

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CTC **Primena VRPM tehnologija u inovativnom razvoju proizvoda** **I3E**

Studija slučaja

VR - 3D visualization
- interaction with virtual environment
- detail inspection of virtual FE model

VR App

SDT data glove, right-handed model with 5 sensors, and 16 predefined gestures

Wintracker, magnetic 6DOF tracking system with 3 sensors

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Studija slučaja

VR - 3D visualization
- interaction with virtual environment
- detail inspection of virtual FE model

vizard - 3D visualization
- SDT data glove
- 3D projector
- Wintracker

Used gestures and associated actions

translation	rotation	scaling	initial position

VR App

vizard

Virtual Reality Application made by IJD

Model translation active

Model rotation paused

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Studija slučaja

VR - 3D visualization
- interaction with virtual environment
- detail inspection of virtual FE model

vizard - 3D visualization
- SDT data glove
- 3D projector
- Wintracker

Virtual Reality Application made by IJD

Powered by vizard

Model translation active

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Virtuelni inženjering u kolaborativnom okruženju – ZAŠTO?

Industrial performance improvement

If all the major players are able to satisfy all the these criteria, a new competitive and cutting edge strategy should comprise tools and techniques for rapid product development (RPD) which are based on virtual engineering technologies.

(V.Mandic, 2011)

Product cost and performance

Quality

Time-to-market

Rapid product development

1980 1990 2000

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Virtuelni inženjering u kolaborativnom okruženju – ZAŠTO?

- ❖ sve oštrija konkurencija na globalnom tržištu
- ❖ kraći životni ciklus proizvoda
- ❖ visoki zahtevi u pogledu kvaliteta proizvoda
- ❖ zahtevi u pouzdanosti isporuke (rokovi)
- ❖ 80% cene proizvoda određeno je u ranoj fazi njegovog životnog ciklusa,
- ❖ traže se načini brzog reagovanja i donošenja odluka
- ❖ proizvodi moraju biti optimizovani sa aspekta kvaliteta i pouzdanosti, u najkraćem mogućem vremenu, i sa minimalnom cenom.

❖ Idealni proces projektovanja za dostizanje ovakvih ciljeva mora funkcionisati u okruženju za virtuelni razvoj proizvoda, gde projektni timovi, celo proizvodno preduzeće, i dobavljači komponenta i usluga, saraduju i imaju brzi pristup kompletnim i ažuriranim projektnim informacijama.

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Virtuelni inženjering u kolaborativnom okruženju – ZAŠTO?

Sto najviše KOŠTA?
SENKA!!!

WHO CASTS THE BIGGEST SHADOW?

INFLUENCE %

70%

20%

5%

5%

30%

15%

50%

5%

PRODUCT DESIGN

MATERIAL

LABOR

OVERHEAD

COST %

Izvor: DIMEG

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Hvala na pažnji

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