

12. Međunarodno znanstveno-stručno savjetovanje SBZ 2023

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023." Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

# THE FUTURE IN SERIAL PRODUCTION WITH HIGH ADAPTABILITY

## Ivica Lacković<sup>1,\*</sup>, Slaven Šimunić<sup>1</sup>

<sup>1</sup>Technical department of University of Slavonski Brod, Croatia

\* Corresponding Author. E-mail: <u>ilackovic@unisb.hr</u>

#### Abstract

Serial production of welded constructions increasingly requires the introduction of new technologies, in this case it is Lorch ROBOMIG technology that provides great opportunities with the much-needed mobility of technology that is not tied to one place and represents a real step towards meeting the needs of serial production. In this case, the computer technology of creating 3D models using Autodesk Inventor would be combined with the possibility of creating parametric models that greatly speed up the creation of the necessary products in serial production, as well as the creation of 2D drawings for production. Such models and processes would be used to create welding parameters and programs that would drive fabrication using Lorch ROBOMIG technology. The parameters and the 3D model will include all the data about the product itself, as well as have the welds shown, which will be programmed into the welding system and, according to the characteristics of the material, determine how the welding process will be executed.

**Keywords:** Fabrication, welded, model, plane, parametric model, Kožul d.o.o, Lorch, Autodesk, Inventor, joint, weld, drawing, material, workshop production, final product.

#### 1. Introduction

Serial production that requires welding technologies in the past has relied on individual workers and their ability to repeat the welding process which has relied on both the worker and the machine to repeat the welding process. Machine quality also has been a point in this process and production. The future of serial production now relies on different points that could be:

- Worker, experience to manage, control and program the process and machine.
- Quality of the welding machine to repeat the process.



12. Međunarodno znanstveno-stručno savjetovanje SBZ 2023

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

- COBOT ROBOMIG Lorch technology to combine first to points and to ensure adaptability and repeatability of the process.
- CAD software Autodesk Inventor Professional 2023.
- Microsoft Excel spreadsheet

Here we meet this technology Lorch COBOT ROBOMIG that can combine above mentioned. With the support of CAD available programs and software the future can be sure to have safe, quality made products with fast and precise products.

#### 2. Software - Autodesk Inventor Professional 2023, Microsoft Excel

Software solution that will be used is Autodesk Inventor<sup>1</sup>. Autodesk Inventor is a middle to high range software solution that can cover all needs for the design and making of welded constructions and parameter models that can support adaptive production and serial production. Autodesk Inventor can create 3D models and assemblies, 2D documentation for manufacturing and has the possibility to create calculations and simulations of created models with finite element methods to check the design and correct possible mistakes in the design before the construction reaches manufacturing. Parameter models are made in support of Microsoft Excel. Autodesk Inventor incorporates "project" technology that separates project files to help the design engineer to save all project files to one location and to be able to manage files easier

Inventor can use multiple standards to be able to cover standards used across the world. Upon installation, Inventor can be adapted to the standard that the design engineer will use for the project. Autodesk Inventor has a big content center database that helps design engineers to make 3D models and welded constructions. This database contains parts from all available standards. Some items in the database are completely defined, example: nuts, bolts, valves, bearings. Other items like beams HE-A and HE-B are used with the feature that can be adapted with length to fit all welded constructions.

#### 3. Modeling with the use of parameters

Autodesk Inventor has the possibility to use parameters from Microsoft Excel spreadsheet<sup>2</sup>. Parameters need to be defined in the first spreadsheet and starting cell is defined in the link process. Two spreadsheets will be defined in the document, first will be with parameters only, two columns, one is the parameter name and other is the value.



#### Društvo za tehniku zavarivanja Slavonski Brod

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

	А	B
1	DimA	150
2	DimB	15
3	DimL	300
4	DimA1	90
5	DimB1	9
6	DimL1	300



In the figure above are the parameters in the first sheet. The second sheet will be with starting values and the descriptions. Formulas are used to calculate values and they are transferred to the first sheet so that Autodesk Inventor can use them as parameters in actual models.

	А	В	с	D	
1	Hrvatski	Engleski	Unos / Entry	Jedinica / Unit	
2	Ukupni parametar skala	Total parameter scale	3		
3	Dimenzija A	Dimension A	50	mm	
4	Dimenzija B	Dimension B	5	mm	
5	Duljina L	Length L	100	mm	
6	Dimenzija A1	Dimension A1	30	mm	
7	Dimenzija B1	Dimension B1	3	mm	
8	Duljina L1	Length L1	100	mm	
_					

Figure 2. Excel spreadsheet with entry values for parameters

Figure above displays entry values for parameters, they are placed in the second spreadsheet. In this spreadsheet descriptions, formulas, values, and all other data can be entered and with the use of formulas it can be transferred to the first sheet. For example, cell C2 contains a parameter called "Total parameter scale" which is used to determine how the whole model behaves. With the entry value of "3", the whole model scale is enlarged three times. With the change of this value, whole model parameters change and model is enlarged or it becomes smaller.

When the actual spreadsheet is completed, then it can be linked to the actual model. In this example all models will be controlled by one spreadsheet. This spreadsheet will contain parameters for all models.



Društvo za tehniku zavarivanja Slavonski Brod "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

The second secon	and formers Trade and	Vice Vice	and o'count					PROTODESK NIT	CITCH Protestronial CAPS	Prostinuo_013	**			and they be contained	0	, ang in the	5.00	0	-
SU Model Sketch Annot	tate inspect loois Ma	nage View	Environments	Collaborate Fus	sion 300 (±) •										-				
📕 🔂 🗐 Sw	veep 🔗 Emboss 🛃 Decal		Chamfer	Thread	📑 Split	& Mark	(into)	Axi	is • 🔚 Rectangular	A Mirror	Face	Stitch	Ruled Surfa	ce 🔄 Replace Face	. 💋	0			
Fatnude Revolve	oft 🔛 Derive 📸 Import	Hole Fil	Shell	Combine	Direct		Shane	Plane	int • 📫 Circular		Roy Convert	Patch	Trim 1	Repair Bodies	Stress	Convert to			
ch 🕈 🖉 Co	oil 🔥 Rib 👌 Unwra	p	Draft	Thicken/ Offset	t 💣 Delete Face		Generator	* 12, UC	S Sketch Drive	en		E Sculpt	Extend	Tit Mesh Face	e Analysis	Sheet Metal			
	Create			Modify *			Explore	Work Feature	es Patte	srn	Create Freeform		Surfac		Simulation	Convert			
+	0 =																		
. 01.107																			
el States: (Primary)																			
Party																			
(fodes(1)											/								3
Primaryl										/									21
n										/									
usion 1									/										
of Part																			
									6										
															<				
										//					1				
										-									
	_																2		
																/	7		
	_															/	)		
																	)		
	_														/	//	)		
	_															/	3		
rameters	_									×					//	/	)		
rameters Parameter Name	Consumed by	Unit/Type	Equation		Nominal Value	Tolerance	Model Value	Кеу	Comment	×						/	3		
rameters Parameter Name ⇒∫ Model Parameters	Consumed by	Unit/Type	Equation		Nominal Value	Tolerance	Model Value	Кеу	Comment	×				$\checkmark$	/	//	3		
rameters Parameter Name == 1200del Parameters H = 40	Consumed by Sketch1	Unit/Type	Equation		Nominal Value	Tolerance	Model Value	Key	Espo Comment	×				$\checkmark$	/	/	3		
rameters Parameter Name 	Consumed by Setch1 Setch1	Unit/Type mm mm	Equation DimB DimA		Nominal Value 15,00000 150,00000	Tolerance Cefault Cefault	Model Value 15,000000 150,000000	Key	Espo Comment	×				$\checkmark$	/	/	3		
rameters Parameter Name 	Consumed by Sectors Sectors Sectors Entruions	Unit/Type mm mm mm	Equation DimB DimA DimS		Nominal Value 15,00000 150,00000 300,00000	Tolerance	Model Value 15,00000 150,00000 300,00000	Key F	Espo Comment	×					/	/	3		
rameters Parameter None    Model Parameters    di    di    di    di    di    di    di	Consumed by Sectifi Sectifi Section 1 Entrucen 1	Unit/Type mm mm mm deg	Equation DimB DimA DimL DimL 0,00 deg		Nommal Value 15,000000 150,000000 0,000000 0,000000	Tolerance Orderfault Orderfault Orderfault	Model Value 15,00000 150,000000 300,000000 0,000000	Key	Comment	×					/	/	)		
rameters Parameter Name  Vodel Parameters	Consumed by Sketch1 Sketch1 Extrusion1 Extrusion1	Unit/Type mm mm mm deg	Equation DimB DimA DimL 0,00 deg		Nominal Value 15,000000 150,000000 0,000000 0,000000	Tolerance @@efault @@efault @@efault	Model Value 15,000000 150,000000 0,000000 0,000000	Key	Comment	×					/	/	3		
Rameters Parameter Name 	Consumed by Sectifi Sectifi Sections Extrusors Sections Sections	Unit/Type mm mm deg	Equation DimB DimA DimA Dimi. 0,00 deg		Nominal Value 15,000000 150,000000 0,000000 0,000000	Tolerance	Model Value 15,000000 150,000000 300,000000 0,000000	Key	Dippo Comment	×					//	/	3		
rameters Parameters Name 	Consumed by Sketch 1 Sketch 1 Sketch 1 Extrusion 1 Extrusion 1 SnetCrive - Sv d1	Unit/Type mm mm em deg em	Equation DimB DimA DamA DamA 0.00 deg 150 mm		Nominal Value 15,000000 300,000000 300,000000 150,000000	Tolerance	Model Value 15,000000 150,000000 0,000000 150,000000	Key F F	Comment	×					/	//			
nameters Parameter None	Consumed by Sketch1 Sketch1 Extrusion1 Extrusion1 ShetCrive - Six d1 o0	Unit/Type mm mm em deg deg mm mm	Equation DimB DimA DimA DimA DimA DimA DimA DimA DimA		Nominal Value 15,00000 150,00000 0,00000 0,00000 150,00000 15,00000	Tolerance Coefault Coefault Coefault Coefault	Model Value 15,000000 30,000000 0,000000 150,000000 15,000000		Comment	×					//	/	3		
nameters Paranter None 	Consumed by Sectori Encourse 1 Encourse 1 Sectorie - Sec d1 00 42	Unit/Type mm mm mm deg mm mm mm mm	Equator Dem8 Dem4 Dem4 Dem4 0,00 deg 190 mm 15 mm 300 mm		Nominal Vake 15,000000 150,000000 0,000000 150,000000 150,000000 150,000000	Tolerance	Model Value 15,000000 150,000000 0,000000 0,000000 150,000000 15,000000 15,000000	Key	Comment	×					//	/	3		
nameters Parameter Name Parameter Name Parameter Name Parameters P	Consumed by Sectors Sectors Ensures Ensures Sectors Ensures di di di di di di	Unit/Type mm em em deg em em mm mm mm	Equation DamB DamA DamA DamA DamA DamA DamA 150 mm 150 mm 150 mm 950 mm		Nominal Value 15,00000 100,00000 0,00000 100,00000 150,00000 15,00000 15,00000 15,00000	Tolerance	Model Value 15,000000 300,000000 0,000000 150,000000 15,000000 90,000000		Comment	×						/	3		
gameters  Parameter Nace  Policie Parameter Nace  Policie Parameters  Policie Paramete	Consumed by Sector Sector Sectors Sect	Unit/Type em em em deg em em em em em em em	Equation DenA DenA DonA DonA Dona 300 mm 300 mm 90 mm 9 mm		Normal Value 15,00000 150,00000 0,00000 0,00000 150,00000 150,00000 90,00000 90,00000	Tolerance	Model Value 15,000000 150,000000 0,000000 150,00000 15,000000 15,000000 90,000000 90,000000	Key 	Comment	×					/	/	3		
Tarantes Tarantes Tarantes 1-00 1-00 1-00 1-00 1-00 1-00 1-00 1-0	Conumed by Sectors Estudiant Estudiant Estudiant Societien - Societien Societien - Societien Societien - Societien Societien - Societien	Unit/Type mm mm mm mm deg mm mm mm mm mm mm mm mm	Equation Den8 Den4 Den4 Den4 Den4 Den4 Den4 Den4 Den4		Nominal Value 15,000000 300,000000 0,000000 150,00000 150,00000 90,00000 90,00000 90,00000	Tolerance	Model Value 15,00000 150,00000 0,00000 0,00000 150,00000 300,00000 90,00000 90,00000 90,00000		Convent	×					/	/	3		
Parameters Parameters Parameter Nome Parameter Nome Parameters Par	Consumed by Berthhil Brandman - Berthhil Distances - Berthil 41 40 42	Unit/Type mm em em deg deg mm mm mm mm mm mm	Equation Dreft Dre		Normal Value 15,00000 190,00000 300,00000 100,00000 150,00000 90,00000 90,00000 300,00000 300,00000 300,00000	Tolerance	Model Value 15,000000 300,000000 0,000000 15,000000 300,000000 9,000000 9,000000 300,000000		Comment	×					/	/			
Paraneters Paraneter Hone	Conumel by Sectol. Estrument Distances Stattive - Sec di di di	Unit/Type mm em deg mm mm mm mm mm mm mm mm	Equation Dank Dank Dank Dank 150 mm 150 mm 150 mm 90 mm 99 mm 9 mm		Normal Value 15,00000 0,00000 0,00000 15,00000 15,00000 90,00000 9,00000 9,00000	Tolerance	Model Value 15,000000 150,000000 0,000000 150,000000 150,000000 90,000000 90,000000 300,000000 300,000000		Comment	×					/				
Autoreters Parameters Parameters 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Consumed by Sectors Sectors Sectors Sectors Sectors 41 60 60 60 60 60 60 60 60 60 60 60 60 60	Unit/Type mm em deg mm mm mm mm mm mm mm mm	Equation DmA DmA 0,00 deg 150 mm 150 mm 3 mm 3 mm 3 mm 3 mm 3 mm 3 mm		Normal Value 15,00000 0,00000 0,00000 0,00000 150,00000 150,00000 9,00000 9,00000 9,00000 300,00000	Tolerance	Model Value 150,000000 150,000000 0,000000 150,000000 150,000000 90,000000 90,000000 90,000000	Key	Popo Consert	×						/			
nameters Paranter Hom - Discher Paranters - 40 - 42 - 4	Conumed by Sectors Estudies Estudies Social	Unit/Type mm mm deg deg mm mm mm mm mm mm fr fr fr	Equation Den8 Den4 Den4 Den4 Den4 150 mm 300 mm 9 mm 9 mm 9 mm 9 mm 9 mm 9 mm 9 mm		Normal Value 15,00000 0,00000 0,00000 15,00000 15,00000 9,00000 9,00000 9,00000 9,00000	Tolerance	Model Value 15,000000 300,000000 0,000000 15,000000 15,000000 9,000000 9,000000 9,000000	Key		×					/	/			
Parameters	Consinel by Beens Beens Beruwen 1 Beruwen 1 Be	Unit/Type mm mm mm mm mm mm mm mm mm m	Equation Dreft Dre		Nommal Value 15,00000 300,00000 0,00000 150,00000 90,00000 90,00000 300,00000 300,00000 300,00000	Tolerance	Model Value 15,000000 300,000000 0,000000 15,000000 90,000000 90,000000 90,000000 90,000000	Key F F F F F F F F F F F F F	Consert	× < <less Done</less 					/	/			

Figure 3. Inventor model with parameters dialog

Figure above displays model with parameters dialog open. In the parameters dialog window can be seen that lower part is the parameters from Excel spreadsheet, and the part above is the use of listed parameters in the actual model itself.

P	Parameters X												
	Par	ameter Name	Consumed by	Unit/Type	Equation	Nominal Value	Tolerance	Model Value	Кеу	Ехро	Comment		
Þ	Ē	Model Parameters											
		d0	Sketch1	mm	DimB	15,000000	Oefault	15,000000					
		d1	Sketch1	mm	DimA	150,000000	Oefault	150,000000					
		d2	Extrusion 1	mm	DimL	300,000000	Oefault	300,000000					
		d3	Extrusion 1	deg	0,00 deg	0,000000	Oefault	0,000000					
		User Parameters											
	÷	D: \Projekti \Privatno \UNISB \OneDrive - Sv											
	1	DimA	d1	mm	150 mm	150,000000	0	150,000000					
		DimB	d0	mm	15 mm	15,000000	0	15,000000					
		DimL	d2	mm	300 mm	300,000000	0	300,000000					
		- DimA1		mm	90 mm	90,000000	0	90,000000					
		DimB1		mm	9 mm	9,000000	0	9,000000					
		L. DimL 1		mm	300 mm	300,000000	0	300,000000					
6													
	T	Add Numeric    Update	Purge Unused		ort from XML				Reset Tole	rance	<< Less		
0	?	Link 🖌 Immediate Upda	ate	f <u>≰</u> Expo	ort to XML				+	<u> </u>	Done		

Figure 4. Parameters dialog

Model with linked Excel spreadsheet does not have to consume all parameters, only the ones that are required for the model itself.



Društvo za tehniku zavarivanja Slavonski Brod "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.



Figure 5. Modeling dialog with parameter for dimensions

Figure above displays red marked dimensions that are parameters from Excel spreadsheet. Dimensions that use parameters are marked with the sign "Fx:". When the user decides to change parameters in the Excel spreadsheet by changing the values them selves or total parameter scale, Autodesk Inventor will be informed about the change and will make an update of the model so that the actual dimensions are as the values in the spreadsheet.

DimA         50 DimB         50 DimL         100 DimA1         30 DimL1         100           DimA1         30 DimB1         3 DimL1         100         Image: State of the s		Peter Peter Smulation Smulation Const	<ul> <li>Taplee Face</li> <li>Repir Bode</li> <li>Repir Bode</li> <li>Fit Mesh Fac</li> </ul>	t ine ach & Autor Surter ach & Tim Gold II Ected Sorters	ter lanvet form	Coute Front	2023 Piennin, J. Minu gular 🔔 Minu ii Divwn Pataen	E Reds	Pere Pere Le US Wok Fature	ek Bage Gewante Espica	©• 3 14 1940	Jz + + fra Prosten 500 4 ∰ Split wir Offvet @ Deints y +	eris Calidad ander El Tor el Conte el Conte Mec		Manage     Manage     Manage     Dend     Dend     Unerrep	Create Cr	December 1000	20 Bant 20 Ban					
DimB       5         DimL       100         DimA1       30         DimB1       3         DimL1       100         Value         Value <td <="" colspan="2" th=""><th></th><th></th><th>N 15</th><th></th><th></th><th>1</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>0</th><th>5</th><th>DimA</th></td>	<th></th> <th></th> <th>N 15</th> <th></th> <th></th> <th>1</th> <th></th> <th>0</th> <th>5</th> <th>DimA</th>				N 15			1													0	5	DimA
Ninc         J           DimL         100           DimA1         30           DimB1         3           DimL1         100						/	1.												5		DimB		
DimL         100           DimA1         30           DimB1         3           DimL1         100				1				1											-	1/	Numl		
DimA1         30 DimB1         33 DimL1         100           rameters         x         x           Permeter Name         Consumed by UN07 permeters         bit N07 permeters         x           Image: Sector and Consumed by Un06 of sources         Dimension A         500000         Consumed by Un06 of sources         x           Image: Sector and Consumed by Un06 of sources         Dimension A         500000         Consumed by Un06 of sources         X           Image: Sector and Consumed by Un06 of sources         Dimension A         500         Dimension A         500           Image: Sector and Consumed by Un06 of sources         Dimension A         500         Dimension A         500           Image: Dimension A         100 mm         3000000         Dimension A         500         Dimension A         500           Image: Dimension A         100 mm         3000000         Dimension A         500         Dimension A         <						30150		1											U	10	JIML		
DimB1         3           DimL1         100		/																	0	3	DimA1		
Dimili         S           Dimili         100		//					X												-		Ni		
DimL1         100           rameters         X           Permeter Name         Conumed by 11         LtVT/type         Equation         Normal Value         Terms for Mail         Sococol Consent         X           Vector for menters         Statuti mm         DmA         Sococol Sococol         Order Mail         Sococol         T           User Filt menters         Statuti mm         DmA         Sococol         Conumed V         LtVT/type         Equation         Normal         Sococol         T           User Filt menters         Statuti mm         DmA         Sococol         Conumed V         LtVT/type         Equation         LtVT/type         Conumed V         Lt		/																					
Ammeters           Volte View of the second of		/	/					/											3		DIMBT		
Parameter Hame         Conumed by UV/Type         Equation         Internal Value         Totar on Volume         Vertice         Vertice         Vertice         Vertice         Conumed by Vertice         Vertice         Ver																			3 0	10	Dimb1 DimL1		
Model Proventers         Mark         Subscience         Subscience         Mark         Subscience         Subscience         Mark         Subscience         Subscience         Subscience         Subscience         Subscience         Subscience         Subscience         Subscience         Subscience         Subscienc								×											0	10	DimL1		
1         0         Sech1         mn         Print         6,00000         0         off-affailt         0,00000         0			/					×	omment	Ευρο	Key	del Value	erance M	Value T	Nomina		Equation	Unit/Type	3 0 sumed by	10	DIMBI DimL1		
Initial         Setters         mm         Driva         0.00000         Orderfail         0.00000         Image: constraint of the setters         Ima								×	omment	Expo	Key	del Value	erance M	Value T	Nomina		Equation	Unit/Type	3 0 sumed by	10	DIMBI DIML1		
1         22         Excusent         em         init         300,0000         - or-efrait         (0,00000)         - r         Hrvatski         Engleski         Unos/Entry           1000         1000         0.00000         - or-efrait         (0,00000)         - r         Ukupni parametar skala         Total parameter skala         Total parameter skala         1000s / Entry           1000         100         30         90         50,00000         - r         Ukupni parametar skala         Total parameter skala         Total parameter skala         100 no         50,00000         - r         Ukupni parametar skala         Total parameter skala         50         50,00000         - r         Ukupni parametar skala         Total parameter skala         50         50,00000         - r         Ukupni parametar skala         Total parameter skala         50           0m4         42         em         30         50,00000         - r         -         Dimenzija A         Dimension A         50           0m41         em         30         30,00000         - r         -         Dimenzija A         Dimension B         5           0m41         em         30         -         -         -         -         Diimenzija A         00         0								×	omment	Expo 1	Key	del Value	erance M	Value T	Nomina		Equation DimB	Unit/Type	3 0 sumed by	10	DIMBI DimL1 ameters arameter Name		
3.3         Excusion1         deg         0.00000         -onfinit         0.00000         -onfinit         Image: Constraint of the second								×	omment	Expo	Key	del Value 00000 000000	erance M Oefault 5, Oefault 51	Value T 0 0	Nomina 5,0000 50,000		Equation DimB DimA	Unit/Type mm	3 0 sumed by	10	DIMBI DimL1		
Imperformatives	Indinio							×	omment		Key	del Value 00000 000000 0,000000	coefault 5, Coefault 5, Coefault 11	Value T 00 00	Nomina 5,0000 50,000 100,00		Equation DimB DimA DimL	Unit/Type mm mm mm	3 0 sumed by ch1 ch1 usion1	10 	DIMBI DimL1 ameters arameter Name		
Openet Prevente Midlig Develore - Sv         Image         State	y Jedinic	Jnos / Entry		Englesk			Irvatski	×	orment	Expo	Key	del Value 000000 000000 0,000000 000000	coefault 5, Oefault 5, Oefault 11 Oefault 10,	Value T 00 (000) 000 (000)	Nomina 5,0000 50,000 100,000		Equation DimB DimA DimL 0,00 deg	Unit/Type mm mm deg	sumed by ch1 ch1 usion1 usion1	1( 	DIMBI DimL1 arameter Name 		
Imm         pin         system	y Jedinic y Unit	Jnos / Entry		Englesk			Irvatski	×	orment		Key	del Value 00000 000000 0,000000 00000	coefault 5, Opefault 5, Opefault 11 Opefault 0,	Value T 00 ( 000 ( 000 ( 000 (	Nomina 5,0000 50,000 100,000		Equation DimB DimA DimL OimL 0,00 deg	Unit/Type mm mm mm deg	sumed by ch1 usion1	1( 	DIMBI DimL1 armeters arameter Name - Model Parameters - 41 - 42 - 43 - 43 - 43 - 43 - 43 - 43 - 43 - 43		
Ome         Office         Office <td>y Jedinic y Unit</td> <td>Jnos / Entry 1</td> <td>i er scale</td> <td>Englesk</td> <td>Tota</td> <td>ır skala</td> <td>Irvatski</td> <td>×</td> <td>omment</td> <td></td> <td></td> <td>del Value 000000 0000000 000000 000000</td> <td>coefault 5. Oefault 5. Oefault 11 Oefault 0.</td> <td>Value T 0000</td> <td>Nomine 5,0000 50,000 100,000 0,0000</td> <td></td> <td>Equation DimB DimA DimL 0,00 deg</td> <td>Unit/Type mm mm deg</td> <td>sumed by ch1 usion1 usion1</td> <td>10 39 39 59 59 59 59 59 59 59 59 59 50 59 50 50 50 50 50 50 50 50 50 50 50 50 50</td> <td>DIMBI DimL1 arenter Name Model Parameters d d d d d d d d d d d d d d d d d d d</td>	y Jedinic y Unit	Jnos / Entry 1	i er scale	Englesk	Tota	ır skala	Irvatski	×	omment			del Value 000000 0000000 000000 000000	coefault 5. Oefault 5. Oefault 11 Oefault 0.	Value T 0000	Nomine 5,0000 50,000 100,000 0,0000		Equation DimB DimA DimL 0,00 deg	Unit/Type mm mm deg	sumed by ch1 usion1 usion1	10 39 39 59 59 59 59 59 59 59 59 59 50 59 50 50 50 50 50 50 50 50 50 50 50 50 50	DIMBI DimL1 arenter Name Model Parameters d d d d d d d d d d d d d d d d d d d		
DmA1         mm         30 mm         30,00000         r         r         Dimenzija B         Dimension B         5           0m81         mm         3 mm         3,000000         0         3,000000         r         r         Dimenzija B         Dimension B         5           0mk1         mm         3 mm         3,000000         0         3,000000         r         r         Dimenzija A         Length L         100           0mk1         mm         100.00000         300.00000         r         r         Dimenzija A1         Dimension A1         30           0         0         0.00000         r         r         r         Dimenzija B1         Dimension B1         3	y Jedinic y Unit	Unos / Entry 1	i er scale	Englesk	Tota	r skala	irvatski	×	omment	Expo		del Value 000000 000000 000000 000000 000000	erance M Opefault 5, Opefault 1, Opefault 0, Si si	Value T 000000000000000000000000000000000000	Nomina 5,0000 50,000 0,0000 50,0000 50,0000		Equation Dim8 Dim4 Dim4 0,00 deg	Unit/Type mm mm deg mm	3 o sumed by ch1 usion1 usion1	10 si si cc si si si si si si si si si si si si si	DIMBI DimL1 DimL1 arater Name 400d Parameters - 40 - 41 - 41 - 42 - 43 - 43 - 43 - 43 - 43 - 43 - 43 - 43		
Dm81         mm         3 mm         3 00000         Imm         Imm         Duljina L         Length L         100           0mr.i         mm         100 mm         100,00000         Imm         Imm<	y Jedinic y Unit	Unos / Entry 1 50	i er scale	Englesk paramete msion A	Tota Dim	r skala	irvatski arameta a A	× F Jpni p nenzij	omment Uku Din			del Value 000000 000000 000000 000000 000000 0000	erance M Opefault 5, Opefault 2, Opefault 0, S, S, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	Value T 00 00 000 00 00 00 00 00 00 000	Nomina 5,0000 50,000 0,0000 50,000 50,000 5,0000		Equation Dim8 Dim4 Dim4 Dim4 Dim4 So mm So mm So mm So mm	Unit/Type mm mm deg mm mm mm mm	sumed by sumed by sh1 usion1 usion1	C S S S S S S S S S S S S S S S S S S S	DIMBI DimL1 arameters arameter Name blood Parameters da da da da da da da da da da da da da		
Operation         Operation <t< td=""><td>y Jedinic y Unit mm mm</td><td>Unos / Entry 1 50 5</td><td>i er scale</td><td>Englesk paramete ension A ension B</td><td>Tota Dim Dim</td><td>ır skala</td><td>irvatski arameta a A a B</td><td>× Ipni p nenzij</td><td>omment Uku Din Dir</td><td></td><td></td><td>del Value 000000 000000 000000 000000 000000 0000</td><td>erance M Obefault S Obefault S Obefault S Obefault S S S S S S S S S S S S S</td><td>Value T 0000 (0000) 0000 (0000) 0000 (0000) 0000 (0000)</td><td>Nomina 5,0000 50,000 100,00 50,000 50,000 5,0000 100,00 30,000</td><td></td><td>Equation Dim8 Dim4 Dim4 0,00 deg 50 mm 5 mm 100 mm 30 mm</td><td>Unit/Type mm mm mm deg deg deg deg deg deg deg deg deg deg</td><td>sumed by ch1 usion1 usion1</td><td>SB (OneDrive - Sv)</td><td>DIMBI DimL1 areaters areater Name - 10000 Parameters - 10000 - 10000 -</td></t<>	y Jedinic y Unit mm mm	Unos / Entry 1 50 5	i er scale	Englesk paramete ension A ension B	Tota Dim Dim	ır skala	irvatski arameta a A a B	× Ipni p nenzij	omment Uku Din Dir			del Value 000000 000000 000000 000000 000000 0000	erance M Obefault S Obefault S Obefault S Obefault S S S S S S S S S S S S S	Value T 0000 (0000) 0000 (0000) 0000 (0000) 0000 (0000)	Nomina 5,0000 50,000 100,00 50,000 50,000 5,0000 100,00 30,000		Equation Dim8 Dim4 Dim4 0,00 deg 50 mm 5 mm 100 mm 30 mm	Unit/Type mm mm mm deg deg deg deg deg deg deg deg deg deg	sumed by ch1 usion1 usion1	SB (OneDrive - Sv)	DIMBI DimL1 areaters areater Name - 10000 Parameters - 10000 -		
Dimenzija A1 Dimension A1 30 Dimenzija B1 Dimension B1 3	y Jedinic Unit mm mm	Unos / Entry 1 50 5	i er scale	Englesk paramete ension A ension B th 1	Tota Dim Dim	ır skala	irvatski arameta a A a B	× µpni p nenzij nenzij	omment Uku Din Din			del Value 000000 000000 000000 000000 000000 0000	erance M Opefault S Opefault J Opefault J Opefault J S S S S S S S S S S S S S S S S S S	Value T 000 000 0000 000 0000 000 0000 000 000 000 000	5,0000 50,000 100,000 50,000 5,0000 100,000 30,000 3,0000		Equation DmB DmA DmA DmA DmA DmA S0 mm 50 mm 50 mm 100 mm 30 mm	Unit/Type mm mm deg deg mm mm mm mm mm mm	3 0 sumed by ch1 ch1 usion1 usion1	LSB/OneDrive - Sv di	DIMBI DimL1 ameters arameter Name - 40 - 42 - 42 - 42 - 42 - 5 - 10 Une Parameters - 1		
Dimenzija B1 Dimension B1 3	y Jedinic Unit mm mm mm	Unos / Entry 1 50 5 100	i er scale	Englesk paramete insion A insion B th L	Tota Dim Dim Leng	ır skala	Irvatski arameta a A a B	× Ipni p nenzij nenzij	omment Uku Dir Dir Du			del Value 00000 000000 000000 000000 000000 00000	erance M Obefault S, Obefault J Obefault J Obefault J S, S, J J J J J J J J J J J J J J J J	Value T 00 0 000 0 000 0 00 0 00 0 000 0 00 0 000 0	Nomine 5,0000 100,00 50,000 50,000 5,0000 100,00 30,000 30,000		Equation Den0 Den4 Den4 Den4 0,00 dep 50 mm 50 mm 30 mm 30 mm	Unit/Type mm mm deg mm mm mm mm mm mm mm mm mm	sumed by ch1 ch1 usion1 usion1	1 ( SB)OneDrive - Sv dd dd dd dd	DIMBI DimL1 ameters araneter Name - Model Prometers 		
	y Jedinic y Unit mm mm mm	Jnos / Entry 1 50 5 100 30	i er scale	Englesk parameter insion A insion B th L ension A1	Tota Dim Dim Lenş Dim	ır skala	Irvatski arameta a A a B a A1	× upni p nenzij nenzij ijina L nenzij	omment Uku Dirn Dirn Du Du			del Value 000000 000000 000000 000000 000000 0000	erance M Opefault 5, Opefault 3 Opefault 10 Opefault 0, 5, 5, 3 3, 3, 3, 3, 10	Value T 000 (000 000 (000 000 (000 000 (000 000 (000 000 (000 000 (000)	Nomina 5,0000 100,00 50,000 50,000 5,0000 100,00 30,000 30,000 100,00		Equation Dend Dent O,00 deg S0 mm 100 mm 3 mm 100 mm 3 mm	Unit/Type mm mm mm deg mm mm mm mm mm mm mm mm	3 sumed by kh1 kh1 usion1 usion1	10 Si Si Si Si Si Si Si Si Si Si Si Si Si	DIMBI DimL1 aneters aranter Nume dod Parameters data data data data data data data dat		
Normalies, 1* Opene range of see Tolerance Dulling 11 Lawreth 11 100	y Jedinic Unit mm mm mm mm mm	Jnos / Entry 1 50 5 100 30 30 3	i er scale	Englesk paramete nsion A insion B th L insion A1 insion B1	Tota Dim Dim Leng Dim	ır skala	Irvatski arameta a A a B a A1 a B1	× H upni p nenzij jina L nenzij nenzij	omment Uku Din Din Din Din Din Din			del Value 00000 000000 000000 000000 000000 00000	erance M Obefault 5, Obefault 11 Obefault 11 Obefault 11 Signed 1 Signed 1	Value T 00 000 0000 000 000 000 000 000 000 000 000 000	Nomina 5,0000 50,000 0,0000 5,0000 5,0000 5,0000 100,00 3,0000 100,00		Equation Den8 Den4 Den4. 0.00 deg 50 mm 50 mm 100 mm 100 mm 100 mm	Unit/Type mm mm deg deg mm mm mm mm mm mm mm mm mm	sumed by ch1 usion1 usion1	1(	DIMBI DimL1 ameters ar ameter Name - 40 - 41 - 42 - 43 - 42 - 43 - 42 - 43 - 44 - 44 - 44 - 44 - 44 - 44 - 44		

Figure 6. Modeling dialog with parameter for dimensions after change of parameters and Excel spreadsheet



Društvo za tehniku zavarivanja Slavonski Brod "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023." Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

Figure above displays what happened when user changed parameters with the change of value "total parameter scale", and all other parameters have changed to new values. Inventor has recognized that change of values happened and is offering to make an update of the model itself by pressing the red marked button in the top row for update of file after change has been accomplished. Figure below will display the changed model after update has been accomplished.



Figure 7. Model state after update

#### 4. Model preparation for the welding process

After models are completed with all parameters set to required values according to the production requirements, material for the models needs to be defined. Inventor has an available list of materials according to the world standards and can define custom materials. Material library contains steel, non-steel and other materials. Each model needs to have materials defined so that Inventor can define parameters for the model and create representations of the model as it would be the part in real life.



Figure 8. Model with defined material and physical characteristics



Društvo za tehniku zavarivanja Slavonski Brod "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.



Figure 9. Assembly model with defined material and physical characteristics

With the definition of physical characteristics and materials, weld configuration needs to be accomplished. Model is transformed into weld assembly so that the weld configuration can be done.



Figure 10. Weld model configuration

Figure 10. displays weld model configuration, fillet weld is configured. This fillet weld configuration will be used later when the actual welding process is defined.

Figure 11. Drawing of model with weld dimensions





12. Međunarodno znanstveno-stručno savjetovanje SBZ 2023

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

#### 5. The Robo-MicorMIG at a glance – Lorch COBOT

- MicorBoost technology. The unparalleled MIG-MAG all-rounder capabilities offered by MicorBoost technology are just as impressive during robot welding. They deliver exceptional arc stability and outstanding mixed gas and CO<sub>2</sub> welding characteristics.
- From exceptionally simple to ... whatever you need. Sporting a no-frills design (feeder, interfaces and operation), the Robo-MicorMIG offers a start into the world of robot welding, while letting you opt for a great number of functions and equipment options if you need them.
- Comprehensive interface technology. Highly advanced interface connectivity supports all common fieldbus and industrial Ethernet systems along with analogue-digital interfaces.
- Innovative upgrade concept. The Robo-MicorMIG can easily be adapted to ever increasing welding requirements by means of NFC technology. It is now possible at any time to upload welding processes, welding programs and functions that boost performance in addition to streamlining your workflow. Thanks to the Robo-MicorMIG you can rest assured that you are always up to date, now and for challenges yet to come.
- Ready for more. The Robo-MicorMIG can be expanded by both the two Speed processes SpeedArc and SpeedUp and by a standard pulse process in order to avoid transition arcs.
- Robo-MicorMIG Lorch COBOT comes with variants that can be adopted to the requirements of the production.

**Figure 12.** Robo-MicorMIG – Lorch COBOT<sup>3</sup>

#### 6. Welding process

In general, about MIG / MAG welding<sup>4</sup>. MIG/MAG welding is also known as gas-shielded metal arc welding, and is one of the welding processes that uses a protective gas shield. This also includes all arc welding processes where shielding gases are used to protect the weld pool from unwanted contact with the oxygen in the ambient air. MIG/MAG welding is two different welding processes: MIG welding stands for metal inert gas welding. This process uses inert, non-reactive – shielding gases such argon, helium, or a mix of the two. MAG welding stands for metal active gas welding. During this process, active shielding gases such as carbon dioxide ( $CO_2$ ) or oxygen ( $O^2$ ) are added to the carrier gas argon. It is, however, also possible to use pure  $CO_2$  as a shielding gas for the weld pool. MIG/MAG welding processes are very versatile and can be used in a range of sectors, including the metalworking industry, shipbuilding, and other. MIG/MAG processes can be used with components



12. Međunarodno znanstveno-stručno savjetovanje SBZ 2023

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

of different thicknesses and geometries, and which are made from different materials. MIG welding is particularly suited to the non-ferrous metals aluminum, magnesium, copper, and titanium. MAG welding is usually used to weld unalloyed, low-alloy, and high-alloy steels.

The actual welding process can be divided into several steps:

- Model examination
- Understanding of drawing
- Preparation of materials
- Preparation of welding machine and process parameters
- Programing of Lorch ROBOMIG COBOT<sup>5</sup>
- Executing the program and welding the product

Here will be displayed one example on the above-mentioned process.

• Model examination and understanding of drawing and material preparation.

Model is created in Autodesk Inventor with the support of Microsoft Excel spreadsheet. Model contains three separate models which are tube, sheet plate and bend sheet plate. All models have the same connecting linked Excel spreadsheet in which all relevant parameters are entered.

Hrvatski	Engleski	Unos / Entry	Jedinica /	_	DimA	100
		,	Unit	Dio/Part	DimT	3
Ukupni parametar skala	Total parameter scale	1			Diml	200
Dimenzija A	Dimension A	100	mm		DIIIL	200
Dimenzija T	Dimension T	3	mm	1	DimD	42,4
Duljina L	Length L	200	mm		DimS	3,2
Dimenzija D	Dimension D	42,4	mm		Diml 1	100
Dimenzija S	Dimension S	3,2	mm	2	Dimer	100
Duljina L1	Length L1	100	mm		DimA1	100
Dimenzija A1	Dimension A1	100	mm		DimT1	3
Dimenzija T1	Dimension T1	3	mm		DimL2	200
Duljina L2	Length L2	200	mm	2	Dim A 2	100
Dimenzija A2	Dimension A2	100	mm	2	DIIIIAZ	100
Dimenzija H	Dimension H	30	mm		DimH	30
Duljina L3	Length L3	50	mm		DimL3	50

**Figure 13.** Export from Excel spreadsheet on the left – entry parameters, on the right – parameters for importing to Inventor

These parameters are linked to all models and all changes applied to one model are applied to others, especially "Total parameter scale" which changes the scale of the whole model. Figure below shows material table that will be used to prepare material required for the execution of the product.



#### "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Društvo za tehniku zavarivanja Slavonski Brod

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.



Figure 14. Model drawing with material table

• Preparation of welding machine and process parameters and programing of Lorch ROBOMIG COBOT

Figure 14 displays a drawing of the model which is required to be produced. On the actual drawing weld are displayed. This model needs to be welded with Fillet weld with height of 2 mm. Weld no. 1 is a fillet weld that welds items 1 and 3, and it is in two sides but different lengths. Weld no. 2 is a two-sided fillet weld between items 1 and 3. Weld no. 3 is a fillet weld that welds items 1 and 2, but

partially, not the whole circle.

When analyzing the drawing and the process is completed, in the COBOT programing package user enters basic parameters of the material that is being welded, the weld shape and size and the program calculates the speed and other process parameters.



Figure 15. Definition of materials and processes parameters in COBOT software



Društvo za tehniku zavarivanja Slavonski Brod "STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023." Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.

After entering the process parameters, programing of the actual COBOT movement needs to be accomplished. This process is simplified by intuitive programing ability of Lorch COBOT, the operator can simply program welding steps by pointing the COBOT by hand to the start, end and intermediate positions with programing key steps in the software.



Figure 16. COBOT in position for programing with one button tack welding

COBOT can tack weld while programing the first production item. Tack welding is executed by one key in the software. After everything is prepared and programed, COBOT can execute a simulation of the programs so that the user can check for all possible issues that can be observed while simulation is executed. Once all the above steps are completed execution, welding the items can be done.

• Executing the program and welding the product

Welding is executed by the program previously done. It can be repeated numerous times. Operator can even setup multiple working positions so that the COBOT can execute multiple welds on multiple items in one operator preparation process.

Figure 17. COBOT welding weld no. 2 above mentioned





Figure 18. COBOT example of finished weld no. 2 above mentioned



12. Međunarodno znanstveno-stručno savjetovanje SBZ 2023

"STROJARSKE TEHNOLOGIJE U IZRADI ZAVARENIH KONSTRUKCIJA I PROIZVODA, SBZ 2023."

Slavonski Brod, 26. i 27. 04. 2023. i Požega 28. 04. 2023.



Figure 19. Finished product welded by COBOT

#### 7. Conclusion

COBOT ROBOMIG Lorch Technology is making a difference in the future world of serial production and adaptation to new requirements. When combined with software tools like Autodesk Inventor and Microsoft Excel it can improve serial production. High adaptability with ease of use makes a good combination to complete complex tasks in welding with the ability to repeat the process without sacrificing quality.

#### 8. Acknowledgement

Acknowledgment belongs to company Kožul d.o.o., Mr. Tihomir Rajić, and CEO of Kožul d.o.o. Mr. Kožul Ivica, Vinogradska 2G, 35000 Slavonski Brod.

Also for Lorch Schweißtechnik GmbH, Im Anwänder 24-26 D-71549 Auenwald, Mr. Jovanović Uroš, and Mr. Wimmer Radek who delivered support materials and all required documentation.

### 9. Literature

- [1] Autodesk Inventor help 2023 user manual: https://help.autodesk.com/view/INVNTOR/2023/ENU/
- [2] Microsoft Excel Office 365 user manual: https://support.microsoft.com/en-us/excel
- [3] Universal Robots e-Series User Manual UR10e Version 5.0.2 2018
- [4] High efficiency welding processes Visokoučinski procesi zavarivanja, I. Samardžić, B. Despotović, str 65. 2002
- [5] 913.1183.1-EN-Lorch-SmartWelding-V6-2022