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THE FUTURE IN SERIAL PRODUCTION WITH HIGH ADAPTABILITY

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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.

- 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[1]. 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[2]. 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.

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

Figure 1. Excel spreadsheet with parameters

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.

	A	B	C	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.

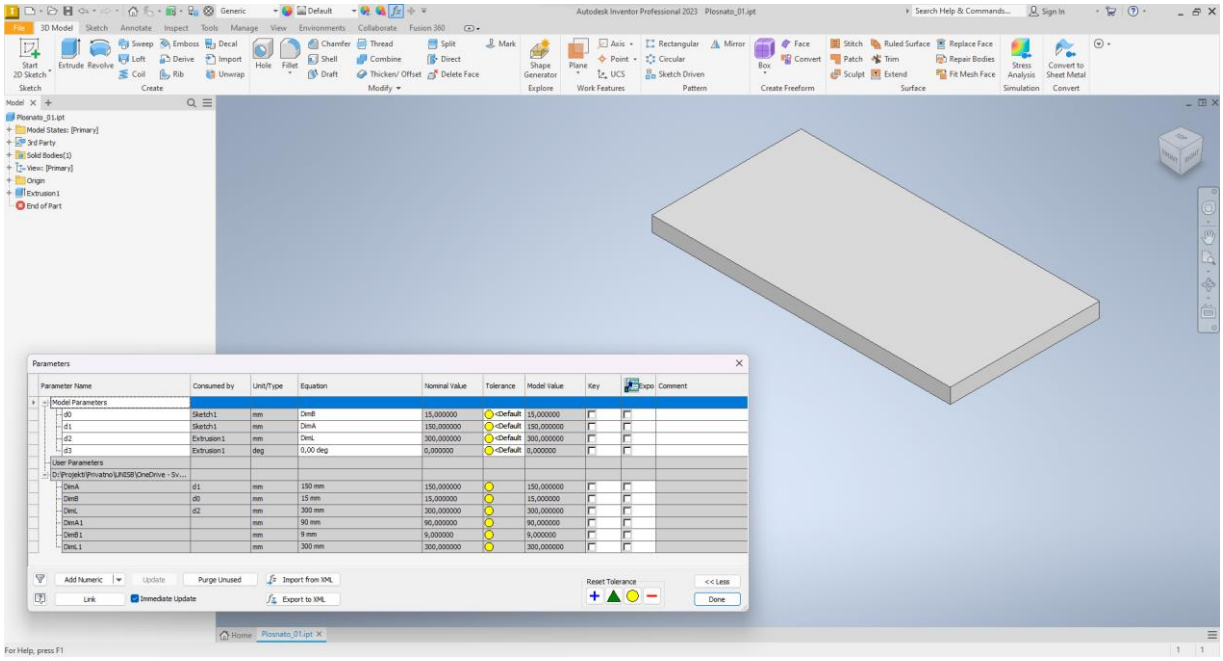


Figure 3. Inventor model with parameters dialog

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.

Parameters

Parameter Name	Consumed by	Unit/Type	Equation	Nominal Value	Tolerance	Model Value	Key	Expo	Comment
Model Parameters									
d0	Sketch1	mm	DimB	15,000000	<Default	15,000000			
d1	Sketch1	mm	DimA	150,000000	<Default	150,000000			
d2	Extrusion1	mm	DimL	300,000000	<Default	300,000000			
d3	Extrusion1	deg	0,00 deg	0,000000	<Default	0,000000			
User Parameters									
D:\Projekti\Privatno\UNISB\OneDrive - Sv...									
DimA	d1	mm	150 mm	150,000000		150,000000			
DimB	d0	mm	15 mm	15,000000		15,000000			
DimL	d2	mm	300 mm	300,000000		300,000000			
DimA1		mm	90 mm	90,000000		90,000000			
DimB1		mm	9 mm	9,000000		9,000000			
DimL1		mm	300 mm	300,000000		300,000000			

Add Numeric | Update | Purge Unused | Import from XML | Reset Tolerance | << Less
Link | Immediate Update | Export to XML | 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.

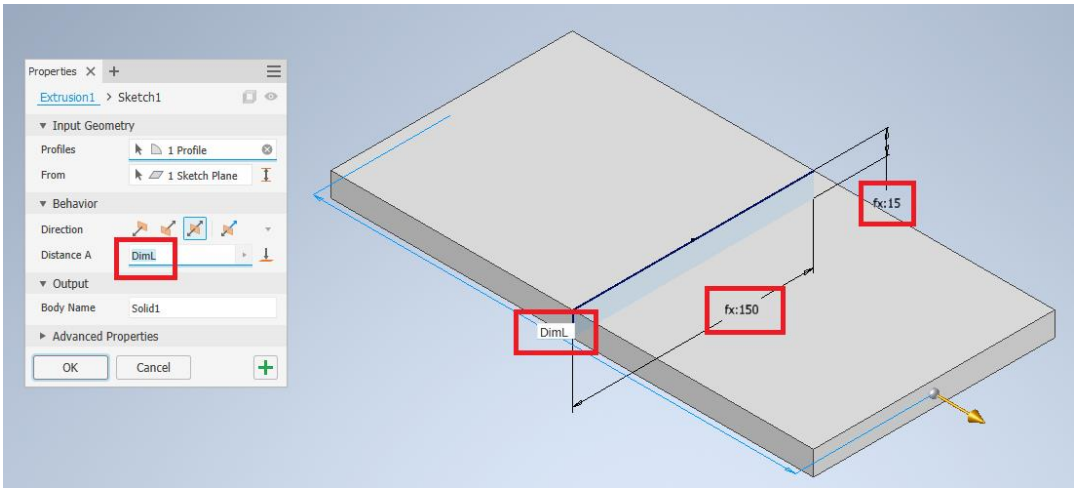
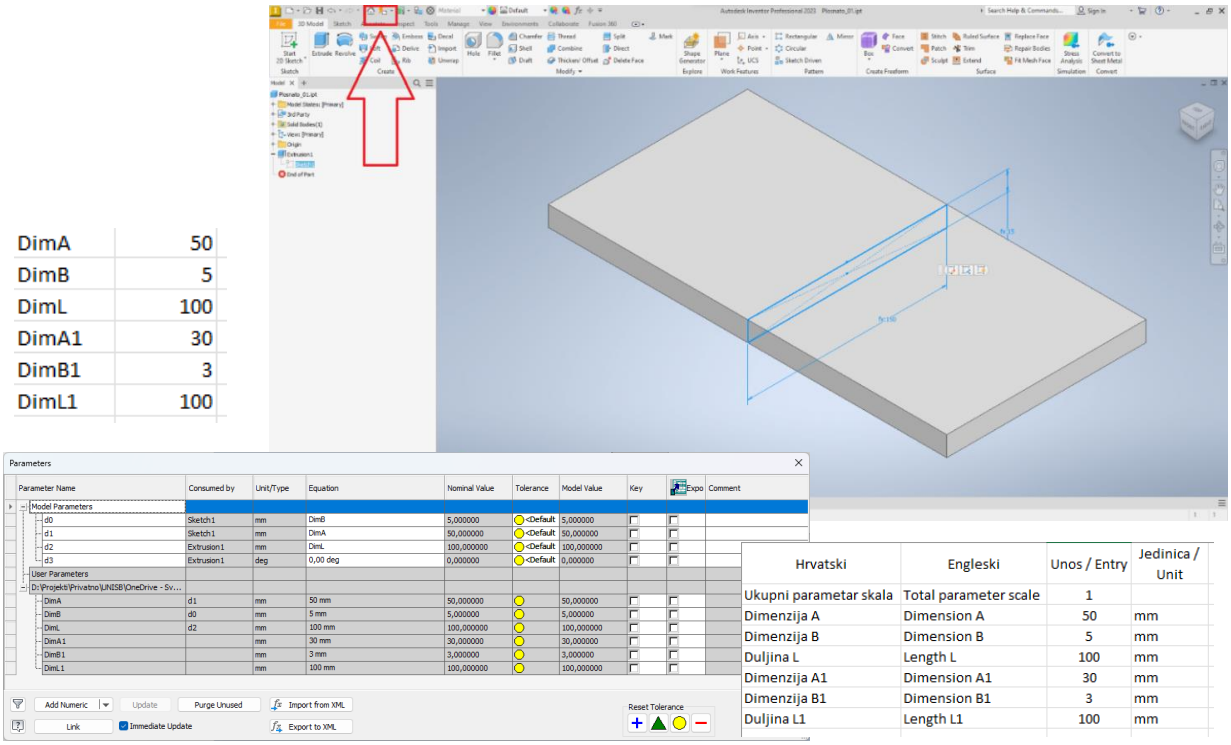


Figure 5. Modeling dialog with parameter for dimensions

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.



Hrvatski	Engleski	Unos / Entry	Jedinica / Unit
Ukupni parametar skala	Total parameter scale	1	
Dimenzija A	Dimension A	50	mm
Dimenzija B	Dimension B	5	mm
Duljina L	Length L	100	mm
Dimenzija A1	Dimension A1	30	mm
Dimenzija B1	Dimension B1	3	mm
Duljina L1	Length L1	100	mm

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

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.

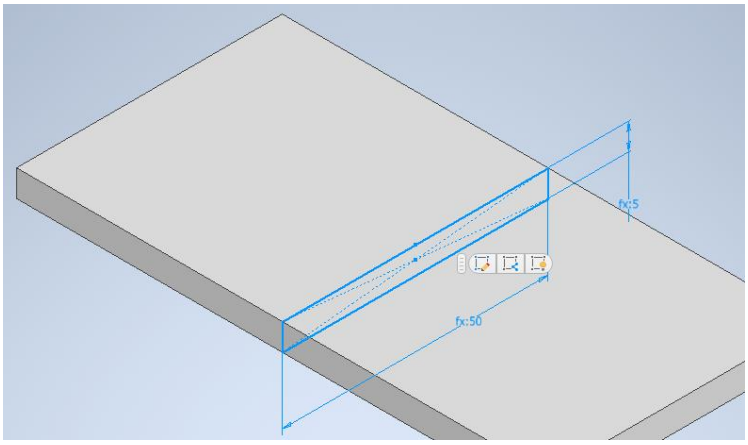


Figure 7. Model state after update

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.

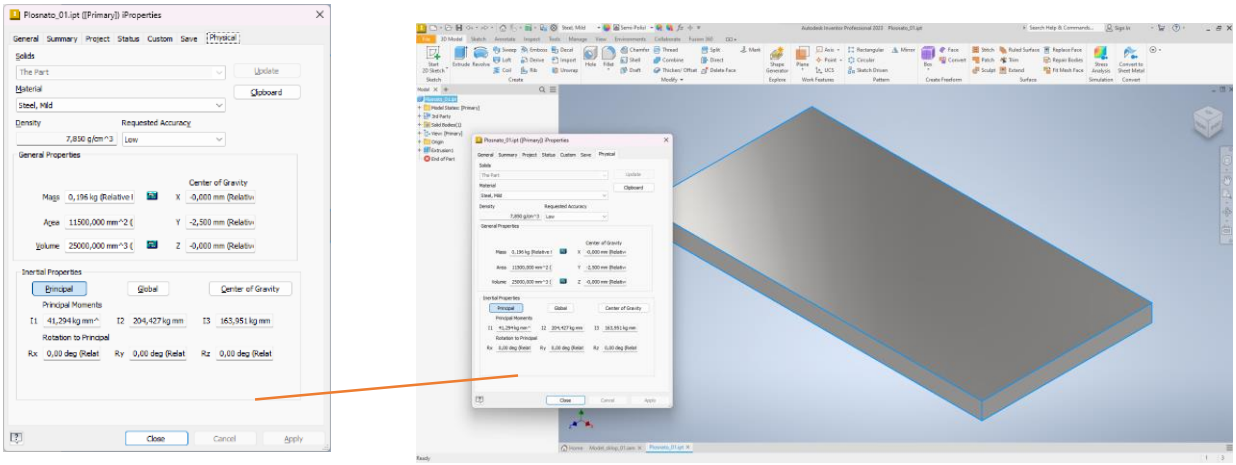


Figure 8. Model with defined material and physical characteristics

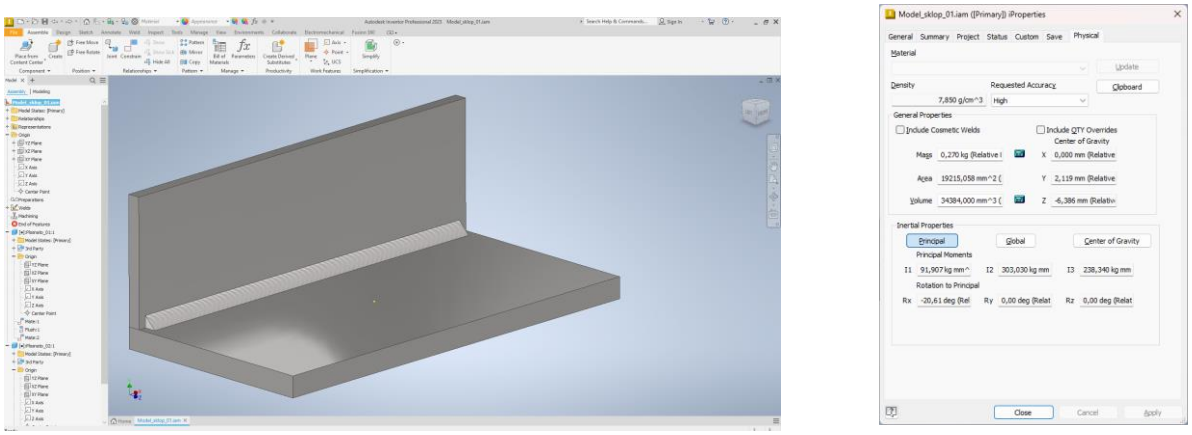


Figure 9. Assembly model with defined material and physical characteristics

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.

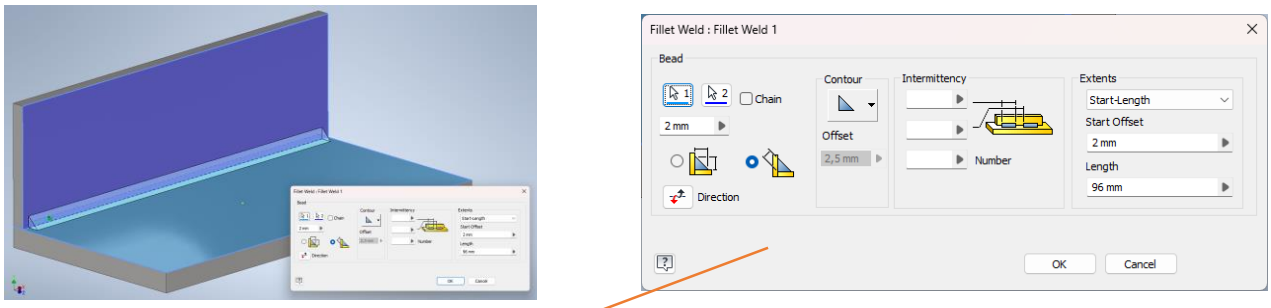


Figure 10. Weld model configuration

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.

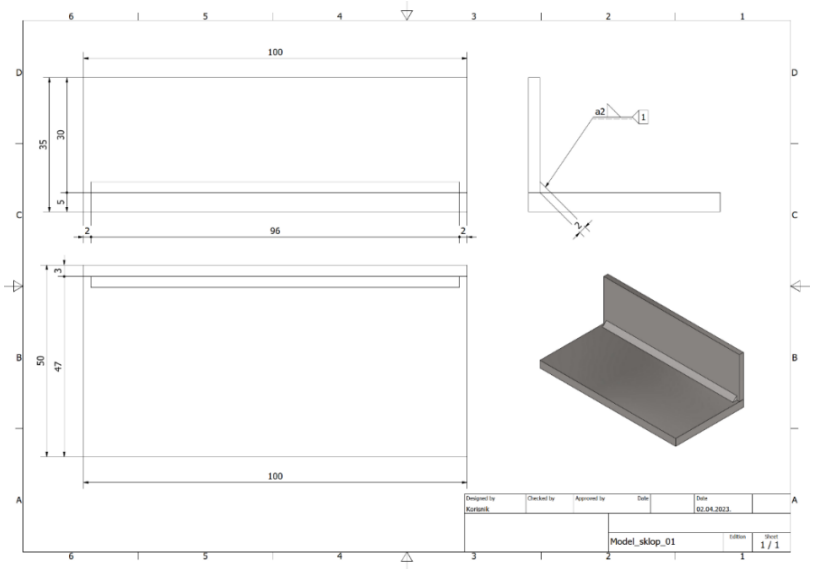


Figure 11. Drawing of model with weld dimensions

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_2 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[3]

6. Welding process

In general, about MIG / MAG welding[4]. 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

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[5]
- 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 / Unit	Dio/Part
Ukupni parametar skala	Total parameter scale	1		
Dimenzija A	Dimension A	100	mm	1
Dimenzija T	Dimension T	3	mm	
Duljina L	Length L	200	mm	
Dimenzija D	Dimension D	42,4	mm	2
Dimenzija S	Dimension S	3,2	mm	
Duljina L1	Length L1	100	mm	
Dimenzija A1	Dimension A1	100	mm	3
Dimenzija T1	Dimension T1	3	mm	
Duljina L2	Length L2	200	mm	
Dimenzija A2	Dimension A2	100	mm	
Dimenzija H	Dimension H	30	mm	
Duljina L3	Length L3	50	mm	

DimA	100
DimT	3
DimL	200
DimD	42,4
DimS	3,2
DimL1	100
DimA1	100
DimT1	3
DimL2	200
DimA2	100
DimH	30
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.

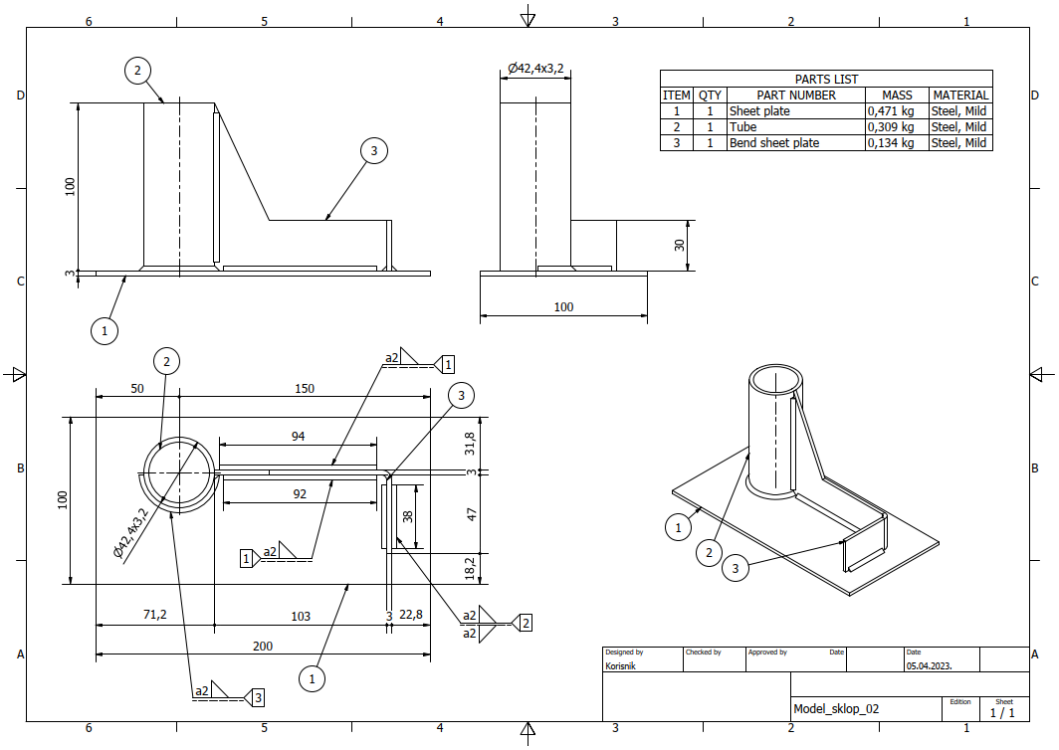


Figure 14. Model drawing with material table

- 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.

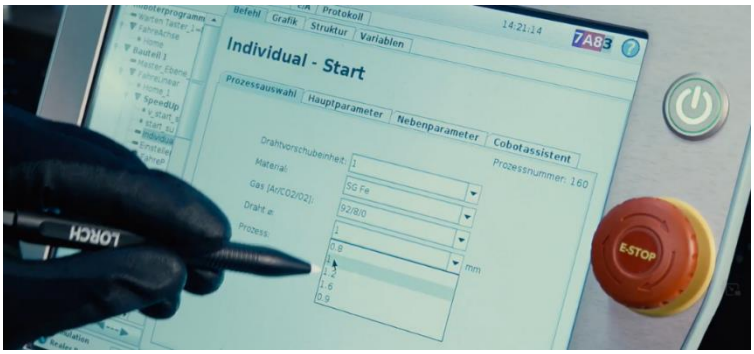


Figure 15. Definition of materials and processes parameters in COBOT software

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.

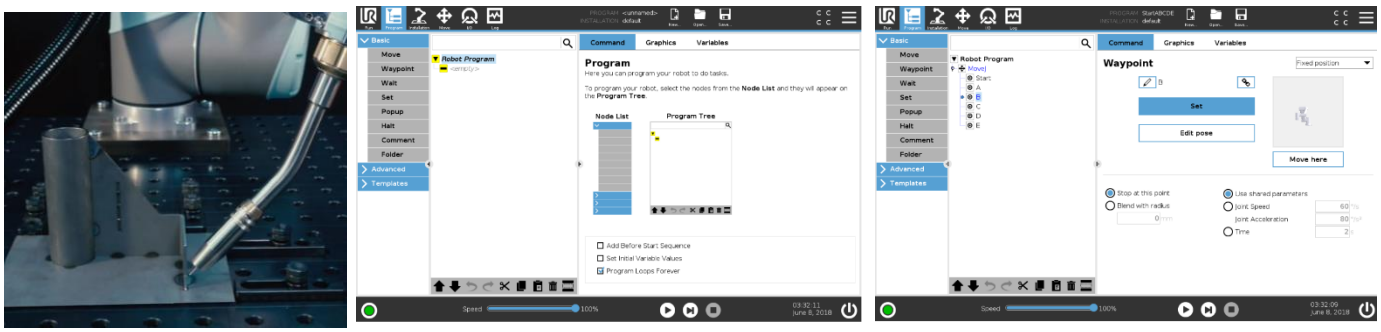


Figure 16. COBOT in position for programing with one button tack welding

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

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

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9. Literature

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