

Faculty of Mechanical Engineering
Brno University of Technology

Review of Doctoral Thesis

1. PhD candidate
Ing. Jakub Slaviček / Jakub.Slavicek1@vut.cz
2. Name of PhD programme
Design and Process Engineering
3. Title of PhD thesis
Additive manufacturing of structured components from magnesium alloys

4. Principal supervisor
doc. Ing. Daniel Koutný, Ph.D. / Daniel.Koutny@vut.cz
5. Co-supervisor
Not listed / E-mail

6. Reviewer
Assoc. Prof. Dr. Damjan Klobčar / damjan.klobcar@fs.uni-lj.si
Faculty of Mechanical Engineering, University of Ljubljana, Slovenia

7. Overview of the scope of PhD thesis¹
Very good
Justification: The dissertation investigates wire arc directed energy deposition (WADED) of the AZ61 magnesium alloy for the fabrication of structured lightweight components. The work is logically structured around four published research papers addressing deposition path planning, CMT process parameter optimisation, thermal management, and volumetric component fabrication. The thesis culminates in a structured component demonstrator that integrates the findings from all four studies. The scope is appropriate for a doctoral-level contribution: the work spans experimental process development, characterisation (microstructure, mechanical properties, porosity, residual stress), and numerical thermal simulation. The 145-pdf document includes four appended journal papers, 102 references, and comprehensive lists of 30 figures, 7 tables, and abbreviations reflect a well-organised and thorough research effort. The thesis clearly identifies scientific questions and formulates testable hypotheses. A minor limitation is that one of the four papers (Research Paper III) was still under review at the time of submission, meaning its peer-reviewed status was not yet confirmed.

8. Significance of the topic and clarity of problem statement
Very good

¹ Overview of the scope of PhD thesis is a short description of objectives of PhD thesis's research and summary of main findings and scientific achievements.

Justification: The application of WADED to magnesium alloys addresses a genuine industrial need: the fabrication of large-scale, lightweight structural components with favourable buy-to-fly ratios. The candidate motivates the topic well, noting that existing studies on WADED of magnesium alloys are limited in scope, typically investigating only a few process parameters and largely ignoring process stability, defect formation, or thermal management. The dissertation clearly identifies these gaps and formulates three scientific questions (Q1–Q3) supported by three pairs of hypotheses (H1a, H1b, H2, H3). The problem statement is succinct, and the research objectives are well defined. The industrial relevance is illustrated through a concrete aerospace use case (aircraft C-shape frame component), which gives the work practical grounding. Overall, the significance of the topic is clear, the problem statement is well articulated, and the research questions are specific and verifiable.

9. Knowledge of existing literature

Very good

Justification: The literature review covers the main aspects of WADED technology (welding power sources, CMT process, path planning, defects) and magnesium alloy science (microstructure, mechanical and thermal properties, weldability). The candidate demonstrates a sound understanding of the state of the art and concludes the review chapter with a well-argued analysis that identifies the specific scientific and research gaps addressed in the thesis. The reference list contains 102 entries, predominantly from peer-reviewed journals of high quality (Additive Manufacturing, Scientific Reports, Journal of Materials Processing Technology, etc.), with publication dates mostly within the last decade. The candidate appropriately situates their own results within the existing literature throughout the Results and Discussion chapters. A minor observation is that some references are review articles rather than primary research papers. Overall, the literature coverage is thorough and appropriate for the scope of the dissertation.

10. Choice of methods and technical soundness

Very good

Justification: The experimental methodology is well chosen and technically sound. The WADED setup is clearly described (KUKA KR 60 HA robotic arm, Fronius TPS 3200 CMT power source), and the development of custom equipment (preheating table, filler wire cleaning system) demonstrates engineering initiative. Characterisation methods are appropriate: optical light microscopy, SEM/EDS, micro-CT, tensile and microhardness testing, 3D optical scanning, and indirect residual stress assessment by deflection measurement. The use of Ansys 2025 with the DED Process add-on for thermal simulation in Research Paper IV is well suited to the research question. The systematic progression from single-track experiments to thin-walled structures and volumetric components follows a logical experimental design. Some limitations are acknowledged honestly, such as the impossibility of extracting standard tensile specimens from volumetric samples, which necessitated microhardness as a proxy measure. The methodology is sound, reproducible, and proportionate to the research questions posed.

11. Quality, originality and significance of the results

Very good

Justification: The dissertation presents several original contributions to the field. The identification of filler wire surface purity as a critical process-related factor, the systematic parametric study of CMT characteristic parameters for AZ61 WADED, and the determination of an optimal preheating/interpass temperature window (200–250°C) are notable findings. The quantitative results are significant: a 40% reduction in residual stress at 250°C preheat, near-full-density parts (99.98% relative material density), and mechanical properties exceeding cast alloys and approaching LPBF-produced counterparts. The use of combined



thermal simulation and targeted experimental validation in Research Paper IV is methodologically strong. The fabrication of the structured demonstrator component adds practical significance. Some results are expected (grain coarsening with higher preheating, deposition strategy affects geometry) and represent confirmations rather than surprises, but their systematic quantification for AZ61 WADED is valuable. The hypothesis H1b was correctly identified as falsified, showing scientific rigour.

12. Quality of attached papers

Good

Justification: Three of the four appended papers are published in peer-reviewed journals: Research Paper I in Journal of Mechanical Science and Technology (Q3, IF 1.7), Research Paper II in Scientific Reports (Q1, IF 3.9), and Research Paper IV in Additive Manufacturing Letters (Q2, IF 4.7). The publication in a Q1 journal for Research Paper II is particularly commendable. Research Paper III was under peer review at the time of thesis submission, which is a limitation. The papers are well-written and contain clear figures, tables, and discussion sections. The candidate's declared contribution ranges from 46% to 70% across the papers, with at least three papers where the candidate is first author. The thematic coherence of the four papers is high, and they collectively address the three scientific questions in a well-structured progression. The rating of Good rather than Very Good reflects that one paper is not yet peer-reviewed and the first paper is in a lower-Q3 journal.

13. Overall assessment, strengths and weaknesses (based upon the above evaluation categories 8–12)

Very good

Strengths: The dissertation is well structured, clearly written, and covers a topic of genuine scientific and industrial relevance. The progressive experimental design — from path planning to process parameters to thermal management to volumetric components — is logical and thorough. The development of custom equipment (preheating table, wire cleaning system) demonstrates engineering ability beyond mere data collection. The integration of numerical simulation and experimental validation is a particular strength. The candidate is transparent about the limitations of each study and correctly identifies one falsified hypothesis (H1b), which indicates scientific integrity. Publication in a Q1 journal (Scientific Reports) is an important achievement. Weaknesses: Research Paper III remains unreviewed, which weakens the completeness of the publication record at submission. Some results in Research Papers I and IV are incremental confirmations of trends known from other materials. The mechanical property characterisation in Research Paper IV relies solely on microhardness due to sample geometry constraints, limiting direct comparison with other WADED studies. Future work could benefit from expanding to post-process heat treatment and longer component geometries to validate the effect of sequencing strategies on residual stresses (H1b).

14. Questions and comments

1. The hypothesis H1b was falsified — deposition sequencing did not reduce residual stresses for 120 mm-long walls. The candidate attributes this partly to the low heat input of CMT. How would the candidate design a follow-up study to determine the minimum wall length at which sequencing strategies become effective for stress reduction using CMT-WADED?
2. Research Paper III reports a 40% deflection reduction at 250°C preheat, used as an indirect indicator of residual stress. What is the uncertainty of this indirect method, and to what extent can deflection measurements be considered a reliable proxy for actual residual stress magnitudes without direct measurements (e.g. XRD or neutron diffraction)?
3. The filler wire cleaning system (2nd generation) proved most effective. Can the candidate comment on the scalability and robustness of this inline cleaning approach in an industrial WADED context, and what

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further development would be needed for industrial deployment?

4.

15. Conclusion

PhD thesis is an independent scientific work that presents a novel solution to a significant problem in the research area and demonstrates the candidate's ability to conduct independent research.

YES

The dissertation by Ing. Jakub Slaviček fulfils the requirements of a doctoral thesis. The work addresses a well-defined research problem, uses appropriate methodology, presents original results, and is supported by three (with one under review) peer-reviewed journal publications. The candidate demonstrates the ability to conduct independent research. The thesis is recommended for defence.

16. Date and signature

23/04/2026

Damian Klobčák

Please note

- A. Evaluate categories 7 to 13 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent. The qualification of 'excellent' should only be given for a PhD Thesis in the top 3% of the research in your field of expertise.
- B. E-mail the completed form to: Klara.Javorcekkova@vut.cz



Review of Doctoral Thesis

1. PhD candidate
Ing. Jakub Slaviček / Jakub.Slavicek1@vut.cz
2. Name of PhD programme
Design and Process Engineering
3. Title of PhD thesis
Additive manufacturing of structured components from magnesium alloys
4. Principal supervisor
doc. Ing. Daniel Koutný, Ph.D. / Daniel.Koutny@vut.cz
5. Co-supervisor
6. Reviewer
Stephan Anton Ucsnik, PhD / Stephan.Ucsnik@ait.ac.at
LKR Leichtmetallkompetenzzentrum Ranshofen GmbH, Austrian Institute of Technology
7. Overview of the scope of PhD thesis¹
Good
Justification for evaluation: This PhD thesis focuses on the holistic research of WADED for AZ61 and how to adjust the process parameters in a best manner from simple, single bead welds over multiple bead welds, their mutual interactions when being deposited according to a path-plan and how to prepare the path-plan strategy best so to achieve an envisaged near-net-shape geometry best without having too much variation in the microstructure and the resulting mechanical properties. The scope of the PhD is good, although it is not stated what the major focus application / sector the study is for. Depending on the sector the one or the other property would be also relevant i.e. stress-crack-corrosion for space, or high yield strength to density or Young's modulus to density in case of space or train. Furthermore, it is confusing that the PhD is on AZ61, but the paper on overhangs is on steel and not being demonstrated / falsified / verified for AZ61.
8. Significance of the topic and clarity of problem statement
Good
Justification for evaluation: It is true, that Magnesium and its alloys are the lightest structural metals which open-up maximum weight savings. In the last 30 years the European automotive and aeronautic industries

¹ Overview of the scope of PhD thesis is a short description of objectives of PhD thesis's research and summary of main findings and scientific achievements.



searched for ways on how to prepare Magnesium alloys for dedicated applications in cars (wheels, roofs, engine hoods, boot lid, ...) or planes (seats, arm rests). But mostly sourcing of Magnesium built the biggest challenge as being vastly dependent from China. Europe just recently started to address this gap and a European Magnesium industry will be raised but this will take 10-15 years to bring it into action. WADED as a young technology has to overcome two major challenges A) acceptance and B) wire sources. But as China is pushing hard (through governmental regulations ->14% of a car must be made of Magnesium in the future) also Europe has to make cars lighter, otherwise driving ranges of Chinese car will be unbeatable and European car industry will fall back even more than today. Literature reviews [Refs 5-6 of the thesis] state the importance of Magnesium in the future, but these reviews have a primal Chinese bias. If this is true for Europe is yet not clear as being vastly dependent on Chinese Magnesium exports and their material price setting. This is true for the automotive industry which would ask for part mass-production (no field for WADED) as well as for aeronautic industry which would ask for parts that can be made by casting or assembly of profiles and metal sheets. It is unclear whether WADED can become a process of choice. This depends hugely on part size, part complexity, and lot number. For this the significance of the topic for Europe is not too high – due to the sourcing problem and lack of resilience. The problem statement itself is sound and clear.

9. Knowledge of existing literature

Satisfactory

Justification for evaluation: The thesis contains a long list of references for what concerns WADED and the different sub-topics like process, process parameters finding, path-planning, material investigation and development etc. What is striking is that the existing literature contains only publications from various indexed journals and books. But the bibliography does not include any publications arising from conferences, those providing information on patents, or those referring to any publications by, for example, ESA, NASA, the FAA or EASA. Also, there is no information about research results from past European or ESA projects which dealt with WADED of Magnesium alloys for space applications (search for project AZ91PMD and company RHP Technology which studied the use of AZ91 for a satellite mirror support structure) or about research results by Cranfield University or Helmholtz-Zentrum Hereon in Geesthacht – Dr. H. Dieringa. As stated, the existing literature is far bigger than the indexed papers from open- or closed-publication providers on the internet.

10. Choice of methods and technical soundness

Very good

Justification for evaluation: The conducted research work of this thesis is according to the state of the art and latest test and evaluation methods have been applied to derive the presented research results. This thesis needed a multitude of different research skills and expertise. On the one hand welding expertise to run the process and fine-tune process parameters, to control the handling system, the robot, to conduct thermal simulations and sensitivity studies using ANSYS WB, to conduct mechanical tests as well as microstructural investigations. The choice of methods is very good, appropriate methods like temperature measurements, surface roughness / parts accuracy assessment through GOM, microstructure analyses of Magnesium together with SEM and EDX have been applied, and results have been collected and prepared in a clear and understandable way. The technical soundness is given.

11. Quality, originality and significance of the results

Very good



Justification for evaluation: The results of this thesis have been prepared and collected so to be published through four SCI-publications as well as additional conference presentations. The quality of the results is very good as scientific standards have been fully and correctly followed. Legends of Figures, Tables, graphs, diagrams are clear and understandable, where needed standard deviation bars or numbers have been presented so that not only absolute values are presented but also the significance of deviations etc. could be assessed. The originality of the results is given as AZ61 is an only poorly investigated Magnesium alloy. Yet it remains unanswered in the thesis why AZ61 was selected for this research. Also, it is unclear what the source of the welding wire was or which company this one provided.

12. Quality of attached papers

Good

Justification for evaluation: There are four attached papers in this paper thesis. Three of them show an impact factor, of which one is published in a Q1-journal, one in a Q2-journal, one in a Q3-journal. For the paper which is attached as a pre-print version it is not stated to which journal it has been submitted and what kind of ranking this journal has. The papers themselves have a clear structure, following high publications standards and quality. The research focus and research questions in the papers is clear and also the outcomes of the papers have been presented clear and objective with a final interpretation of results, conclusion and outlook view for the following research path. Papers 1 and 3 could have been submitted to higher level journals. Eventually, paper #3 has been submitted to a higher-level journal, but this is not stated.

13. Overall assessment, strengths and weaknesses (based upon the above evaluation categories 8–12)

Good

Justification for evaluation: The thesis' main focus is the research of AZ61 welding wire being processed by WADED to thin wall structures, volumetric structures as well as the influence of process parameters, welding wire quality and path strategy on the overall quality of the WADED-built structures. A systematic approach has been followed which started with initial research questions, research hypothesis, a definition of research path for a structured and well-organized research work for this thesis. The systematic research of the set questions and hypotheses have led to answers / best parameter sets, heat treatments, pre-heating of parts together with interpass temperatures which at the end of the thesis allowed to manufacture a cut-out of a big-size demonstrator. This is a clear strength which shows the success of this thesis. Unfortunately, the thesis contains a chapter that shows research work on steel using G3Si welding wire and ways to realize overhangs. That is clearly a very interesting topic, but only if the candidate could have transferred this finding towards AZ61 and presented this instead of G3Si the thesis would be according to its title "Additive manufacturing of structured components from Magnesium alloys". This is a weakness of this thesis. Likewise, that this kind of overhangs have not been demonstrated on the final component.

14. Questions and comments

- Q1: Why is one part of the thesis focusing in overhangs using G3Si welding wire instead of AZ61
Q2: What kind of real target application does the candidate see?
Q3: What are the sources of the AZ61 or other Magnesium alloy welding wires?
Q4: Have Data Science, AI or Machine Learning approaches been used so to derive further insights or process improvements? Is there any future intention to do so?
Q5: Why was AZ61 alloy selected for the research work in this thesis?
Q6: Why was the Aircraft C-Shape Frame selected as demonstrator? Would it need a redesign for



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WADED?

Q7: Is the wire cleaning system possible to be used for long-term runs (24/7)?

Q8: Is it possible to do WADED of Magnesium in the future or is it already patented by Chinese companies so that it is not open for future use for Europe?

Q9: Has there been a comparison between SMAW / GMAW / CMT so to show the effect of CMT on residual stresses?

15. Conclusion

PhD thesis is an independent scientific work that presents a novel solution to a significant problem in the research area and demonstrates the candidate's ability to conduct independent research.

YES

16. Date and signature

03/07/2026

Please note

- A. Evaluate categories 7 to 13 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent. The qualification of 'excellent' should only be given for a PhD Thesis in the top 3% of the research in your field of expertise.
- B. E-mail the completed form to: Klara.Javorcekova@vut.cz



Principal supervisor's final report on the PhD study

1. PhD candidate
Jakub Slaviček / Jan.Jaros2@vut.cz
2. Name of PhD programme
Design and Process Engineering
3. Title of PhD thesis
Additive Manufacturing of Structured Components from Magnesium Alloys

4. Principal supervisor
Assoc. prof. Ing. Daniel Koutný, Ph.D. / Daniel.Koutny@vut.cz
5. Co-supervisor
- / -

6. Stays at other institutions (min. 7 days)
University of Applied Sciences Upper Austria/ Wels/ Austria / 02/04/2024 / 31/05/2024

7. Teaching activities
CAD / 468 hrs Design and CAD / 234 hrs Additive Technologies / 18 hrs

8. List of main publications
Papers published in journals with impact factor: SLAVÍČEK, J.; FRANKE, J.; JAROŠ, J.; KOUTNÝ, D.; Strategies for Wire Arc Additive Manufacturing of thin walls and overhangs, <i>Journal of Mechanical Science and Technology</i> , 2023, vol. 37, no. 1, p. 5529-5534, ISSN: 1738-494X. <i>Journal impact factor = 1.5, Quartile Q3, Citations = 10</i> SEIDLER, F.; SLAVÍČEK, J.; KOUTNÝ, D.; Influence of deposition strategy on the microstructure of volumetric WADED-fabricated AZ61 magnesium alloy components, <i>Additive manufacturing letters</i> , 2025, vol. 16, p. 1-10, ISSN: 2772-3690 <i>Journal impact factor = 5.2, Quartile Q2, Citations = 0</i> CHOVANČÍKOVÁ, V.; GULAN, L.; KOREC, F.; NOVÁK, P.; SLAVÍČEK, J.; ĎURIŠKA, M.; Comparison of methods of topological optimization of a selected module of a mobile working machine and assessment of the possibilities of production by additive technology, <i>Advances in Science and Technology Research Journal</i> , vol. 19, no. 10, p. 199–211. ISSN: 2080-4075.



Journal impact factor = 1.5, Quartile Q3, Citations = 0

SLAVÍČEK, J.; ŠVÁB, Č.; GNEIGER, S.; HURNÍK, J.; PROCHÁZKA, P.; KOUTNÝ, D.; Wire-arc directed energy deposition of AZ61 magnesium alloy fabricated by cold metal transfer: Processing, microstructure, and mechanical properties, *Scientific Reports*, 2026, vol. 16, no. 1, p. 1-17, ISSN: 2045-2322

Journal impact factor = 4.9, Quartile Q1, Citations = 2

SLAVÍČEK, J.; ZEMAN, S.; HORYNOVÁ, M.; SENCK, S.; KOUTNÝ, D.; Optimisation of preheating and interpass temperature in WADED magnesium alloy AZ61: A comparative study on microstructure, residual stresses, and internal defects, *Journal of Advanced Joining Processes*, 2026, vol. 13, p. 1-15, ISSN: 2666-3309.

Journal impact factor = 4.4, Quartile Q1, Citations = 0

Participation at conferences:

SLAVÍČEK, J.; HURNÍK, J.; KOUTNÝ, D. Strategy for wire arc additive manufacturing of thin walls. Reliability and Design of Additively Manufactured Materials, 4.–6.10. 2022, Belgrade, Serbia.

SLAVÍČEK, J.; ŠVÁB, Č.; ZEMAN, S.; SEIDLER, F.; HORYNOVÁ, M.; GNEIGER, S.; SENCK, S.; KOUTNÝ, D. Process development for thin-walled AZ61 components produced by WADED, 1.st MEBioSys conference, 9.–10.9.2025, Brno, Czech Republic.

SLAVÍČEK J., ŠVÁB Č., ZEMAN S., SEIDLER F., HORYNOVÁ M., GNEIGER S., SENCK S., KOUTNÝ D. Process Development for Complex Magnesium Alloy Parts Produced by WADED. 3rd International Conference on Advanced Manufacturing Space, Aerospace and Land Applications, 8-11.6.2026, ESA Estec, Netherlands.

9. Assessment of the supervision process

Very good

Justification for evaluation: The main communication with the doctoral student regarding the topic of his thesis was carried out in the form of regular meetings on weekly bases. More detailed discussions of the topic of the dissertation, including planned experiments, partial results and proposals for further steps, then took place approximately every four to six months. The student also actively discussed specific topics of prepared studies with and other experts in the materials characterisation field. Throughout the course of the study, communication went smoothly, and certain disruptions and slowdowns in activities only occurred during the COVID-19 pandemic.

10. Assessment of the candidate's ability to work independently

Excellent

Justification for evaluation: The doctoral student proved his ability to work independently. From the beginning of the studies, he participated in several research projects. The tasks he received were done on time and in a good quality. He proved to be capable to guide student in bachelor and master thesis. Student prepared and solved one educational faculty project for subject Additive Technologies and one faculty internal project related to his PhD topic "The strategy for wire arc additive manufacturing of overhangs". During the projects, he showed that he is able to independently plan experiments, evaluate the results and prepare final research reports. The student also demonstrated the ability to formulate hypotheses on his own research and test them with experiments he designed. During his studies, he initiated cooperation with researchers from STU Bratislava and TU Delft.

11. Assessment of the contribution that the research makes to knowledge in the field
Very good

The dissertation makes a significant and original contribution to the field of wire arc directed energy deposition (WADED) of magnesium alloys, addressing several important research gaps that have limited the wider application of this technology. The work provides a systematic investigation of deposition path planning, characteristic CMT process parameters, and thermal management, establishing clear relationships between process conditions, geometrical accuracy, microstructural evolution, residual stresses, and defect formation. Particularly valuable is the comprehensive study of AZ61 magnesium alloy, for which fundamental knowledge on process optimisation has previously been limited. A major contribution lies in the development of practical processing strategies that enable stable fabrication of thin-walled, overhanging, and volumetric components while improving component quality and process robustness. The dissertation also introduces new experimental equipment and methodologies, including customised thermal management and filler wire preparation systems, which substantially expand the research capabilities in this area. The successful fabrication of a representative structured demonstrator confirms the practical applicability of the developed approaches. Overall, the research advances both the scientific understanding and industrial potential of WADED processing of magnesium alloys and provides a solid foundation for future developments in lightweight structural additive manufacturing.

12. Other comments

Project on which student participated or led during his PhD studies:
 2023 – 2028, MEBioSys – Mechanical Engineering of biological and bioinspired systems, CZ.02.01.01/00/22_008/0004634, Ministry of Education, Youth and Sports, team member
 2023 – 2027, TAČR FW09020130, Robotic cell for hybrid manufacturing in Industry 4.0, team member
 2022, FSI-K-22-7661, The strategy for wire arc additive manufacturing of overhangs, investigator
 2021-2023, OP-PIK CZ.01.1.02/0.0/0.0/21_374/0026857, Increasing the shear and flexural strength of composite profiles by using 3D elements for guiding and shaping the mats, team member
 2020-2022, ATCZ229, Research of magnesium alloys for additive manufacturing of structural and biomedical parts, team member

13. Conclusion

PhD thesis is an independent scientific work that presents a novel solution to a significant problem in the research area and demonstrates the candidate's ability to conduct independent research.

YES

14. Date and signature

15/07/2026

Please note

- Evaluate categories 9 to 11 using the following scale: unacceptable, acceptable, satisfactory, good, very good, excellent.
- In each category 9 to 11 explain reasons for evaluation using between 100–200 words.
- E-mail the completed form to: Klara.Javorcekkova@vut.cz