Industry showcase 2023

MATEng & MOD Research groups



Our Research in Context: Materials Tetrahedron

Performance

• Resource efficient process chains

Characterisation

- Digital image correlation
- AM and PM powder analysis

Structure o

- LPBF microstructure
- Tailored heat treatments
- Porosity

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Processing

- AM Laser powder bed fusion (LPBF)
- Powder metallurgy (PM)



Gel casting

Properties

- Mechanical testing
- Fracture and fatigue testing



Research Topics: Processing

Laser Power Bed Fusion (LPBF)





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- Collaborations with Stellenbosch Technology Centre Laboratory for Advanced Manufacturing (STC-LAM) and Industrial Engineering (SU)
- Two LPBF machines at STC-LAM:
 - LaserCusing M2 (Concept Laser GmbH)
 - Mlab 200R (Concept Laser GmbH) operated by HH Industries
- Materials studied:
 - Titanium alloys (Ti6Al4V), maraging steel, metal matrix composites (WC-Co), nickel superalloys







Photos by G Ter Haar and D Hagedorn-Hansen (Mlab 200R)

Engineering | EyobuNjineli | Ingenieurswese





Source: Parker (2021) supervised by Prof Deborah Blaine

Engineering | EyobuNjineli | Ingenieurswese



Source: Parker (2021) supervised by Prof Deborah Blaine

Research Topics: LPBF

Characterisation: Powder Characterisation



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Source: Parker (2021) supervised by Prof Deborah Blaine

Engineering | EyobuNjineli | Ingenieurswese

Research Topics: LPBF

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Processing and Structure: Porosity-Ti6Al4V



Source: Ter Haar (2021) supervised by Prof Thorsten Becker

Engineering | EyobuNjineli | Ingenieurswese

Research Topics: LPBF

Structure: Microstructure - Ti6Al4V

Pi modal r

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Engineering | EyobuNjineli | Ingenieurswese

As-built

3 hours beta anneal



Engineering | EyobuNjineli | Ingenieurswese

supervised by Prof Thorsten Becker

Research Topics: Resource-Efficiency

Performance: Machining



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Source: Dimitrov et al. (2018), Aerosud Aviation, SU & Fraunhofer Institute for Machine Tools and Forming Technology

Research Topics: Resource-Efficiency

Performance: Forming + Machining







Source: Dimitrov et al. (2018), Aerosud Aviation, SU & Fraunhofer Institute for Machine Tools and Forming Technology

Research Topics: Performance



Performance: AM + Machining



Composed pre-part

Source: Dimitrov et al. (2018), Aerosud Aviation, SU & Fraunhofer Institute for Machine Tools and Forming Technology



Research topics: Performance

Resource-Efficient Process Chains: Titanium Alloys







Source: Dimitrov et al. (2018), Aerosud Aviation, SU & Fraunhofer Institute for Machine Tools and Forming Technology

Research Topics: Characterisation Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT **Digital Image Correlation** DIC: full-field data (UCT, Conventional: strain gages, extensometers Open University UK) Small sample testing: University of Bristol Virgin X20 0.06 8 mm -∆---*T* = 600 °C 25 -O— T = 597 °C diameter 0.05 *− T* = 591 °C T = 581 °C 20 disc - T = 568 °C × 0.04 -∇--- T = 551 °C $\epsilon_{\rm max}$ = 0.28, r_{max} = 1.06 mm ε_{norm} Strain *a* 15 — *T* = 529 °C -00⁰⁰⁰⁰⁰⁰ Strain (%) 0.6 0.03 Creep 10 0.5 2 0.02 0.4 (mm) 5 0.3 > 0.01 0.2 0 200 400 600 0.1 Time (hours) 0 6 8 -2 2 0 Time (hours) x (mm)

Mechanical & Mechatronic Engineering

Source: van Rooyen (Neaves) (2021) supervised by Prof Thorsten Becker

Research Topics: Characterisation Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT **Digital Image Correlation** Limited material supply: E 2000 New X20 5 9 10 Low damage Medium damage Image divided into subset windows A ... - 9 ... High damage 12 % Cr steel: X20CrMo12-1 (X20 for short) Source: van Rooyen (Neaves) (2021) supervised by Prof Thorsten Becker

Mechanical & Mechatronic Engineering

Source: van Rooyen (Neaves) (2021) supervised by Prof Thorsten Becker

Research Topics: Characterisation

Digital Image Correlation

• Creep testing using DIC + thermal imaging + Gleeble (UCT)







Mechanical & Mechatror

Materials Engineering (MATENG) **Research Group**



Academic Members





Prof Deborah Blaine

Dr Nur Dhansay

Mr Raymond Botete



Dr Gerrit Ter Haar



Mr Llewellyn Cupido



Dr Melody Neaves

Our Research Scope

- Fracture mechanics
- Damage mechanics
- Material characterisation •
- Digital image and volume correlation
- Microstructural analysis
- Powder metallurgy processing
- Powder characterisation
- Gel casting
- Additive manufacturing
- Finite element modelling •
- Small specimen testing

MOD research group

- Materials, Optimisation and Design (MOD)
- Core expertise:
 - Material characterisation
 - Optimisation
 - Structural analysis and design
 - Experimental validation



Prof Gerhard Venter



Prof Martin Venter



- Infrastructure:
 - High-end desktop machines
 - Access to high-performance computing
 - Extensive range of software
 - Test & measurement facilities



Mr Johann Bredell

Case studies of industry-focused research



Company	Industry	Торіс
Triz Engineering	Automotive	Influence of high-strength low-alloy (HSLA) steel on the fatigue life of welded joints in the automotive industry
Scatec	Renewable energy Solar PV	Structural analysis and design relating to photovoltaic single-axis trackers
Golden Arrow Bus Services	Automotive Transportation	Influence of electric vehicle (EV) conversions on the safety of passenger vehicles

Triz Engineering (Automotive)







Research question

Are code-based fatigue design methods representative of welded joints using HSLA steels?

- A bursary was offered to Master's degree student
- Bursary conditions stipulated in contract between SU and partner

Output

- Human capital
- Skills development
- Industry-relevant research output



- A comprehensive project proposal was generated
- Project proposal was presented to partner for approval
- Continuous feedback on progress was provided

Triz Engineering (Automotive)









Combination	Α	В	C
Parent material	S 355 JR	STRENX 700	STRENX 700
Filler material	ER 70S	ER 70S	ER 100S
Watching	Matched	Under-matched	Matched

T-joint

- Fatigue performance was dependent on parent and filler materials
- S 355 JR performed better than STRENX 700
- BS 7608 is conservative

Cross-joint

- Failure location depends on load magnitude
- Fatigue performance less sensitive to materials
- STRENX 700 did not outperform S 355 JR
- BS 7608 is conservative

Author: G Ramsay (MEng Thesis)

Scatec (Renewable energy, Solar PV)







- Experimental tracker array outside Stellenbosch Mariendahl
- Test & measurement facilities to perform mechanical load testing



GABS (Automotive, Transportation)









- Golden Arrow Bus Services (GABS) celebrated their 160th birthday in 2021
- MOU and bursaries for postgraduate studies
- Journey to renewable energy
 - Two solar PV plants making facilities carbon neutral
 - Two electric busses currently in service

UNIVERSITY IYUNIVESITHI UNIVERSITEIT The Gus For L PH2 PH3 8000 Plastic hinge 1/4 50x50x3 unmodified Plastic hinge 2 7000 14 50x50x3 composite reinforcement Plastic hinge 3 **RESIDUAL SPACE** 50x50x3 relocated plastic hinges PH1 6000 12 Moment (Nm) 4000 3000 Energy (kJ) 9 8 01 PH1 PH4 RESIDUAL SPACE 6 2000 1000 PH3 2 PH4 0 5 0 10 15 20 25 0.1 0.2 0.3 0.5 0.6 n 0.4 Rotation (°) Displacement (m)

- EV bus conversions i.e. existing superstructures on EV chassis
- What is the effect on EV conversions on passenger safety?
- UN/ECE Reg. 66 Requirements for superstructure strength (Roll-over protection)
- UN/ECE Reg. 100 Requirements for electric power train (Mechanical shock protection)

GABS (Automotive, Transportation)





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Summary

- We are flexible
- We are well-equipped
- We collaborate internally
- We collaborate with industry
- We have a proven track record of human capital and skills development to address the needs of industry







Cattanting-

Thank you Enkosi Dankie

Photo by Stefan Els