

Hochschule Offenburg

# Interdisciplinary Doctoral Candidates' Colloquium 2025

**Engaging in Research Dialogue**

Graduate Academy  
17.7.2025



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## Program of the Colloquium

| Opening                                                      |                                                           |                        |
|--------------------------------------------------------------|-----------------------------------------------------------|------------------------|
| For organizational reasons, there will be no Zoom broadcast. |                                                           |                        |
| Panels                                                       |                                                           |                        |
|                                                              | 1) Sustainable Futures<br>2) Health and Well-Being        | Smart Digitalisation   |
| 15:15-15:30                                                  | Alexander Gehringer (ENG, Sustainable Futures)            | Jennifer Blöchle (DEU) |
| 15:30-15:45                                                  | Philip Guerra Nunez (ENG Sustainable Futures)             | Charleen Baumann (ENG) |
| 15:45-16:00                                                  | Anna Sandhaas (ENG, Sustainable Futures)                  | René Zandomeni (ENG)   |
| 16:00-16:15                                                  | Héctor Alfonso Durán Guerra (ENG, Sustainable Futures)    | Mas ´udah (ENG)        |
| 16:15-16:45                                                  | Coffee Break / Networking- 30 min                         |                        |
| 16:45-17:00                                                  | Meritxell Domènech Monfort (ENG, Sustainable Futures)     | Bianca Lamm (ENG)      |
| 17:00-17:15                                                  | Sebastian Roth (ENG, Health and Well-Being)               |                        |
| 17:15-17:30                                                  | Sebastian Rehorst (ENG, Health and Well-Being)            |                        |
| 17:30-17:45                                                  |                                                           |                        |
|                                                              |                                                           |                        |
| Starting at 18                                               | Closing of the Colloquium and Get-Together in the D Foyer |                        |
| For organizational reasons, there will be no Zoom broadcast. |                                                           |                        |

### Zoom Panel Sustainable Futures & Health and Well-Being

<https://hs-offenburg.zoom-join.com/j/63091757093?pwd=FjOmFLFSPAdRZtuzDE7rPVZRIdhfAC.1>

Meeting-ID: 630 9175 7093; Kenncode: 803795

### Zoom Panel Smart Digitalisation

<https://hs-offenburg.zoom-join.com/j/62854568836?pwd=5qayoL3Jb2VLfBvUPAXNlu4Cs32Pin.1>

Meeting-ID: 628 5456 8836; Kenncode: 889930

## Contributions in alphabetical order

### **Baumann, Charleen:** Understanding Intergranular Fractures Using Digital Material Twins

In nickel-based superalloy components operating at high temperatures, such as rotor disks in aero engines, intergranular cracking can be a critical failure mode. The accelerated crack propagation along grain boundaries is driven by the combined effects of fatigue and oxygen diffusion and is described as dynamic embrittlement. The damage mechanism is highly depending on the characteristics of grain boundaries and limits the application of polycrystalline high-temperature superalloys. Hence, a reliable computational method for the assessment of intergranular cracking in polycrystalline alloys is required.

It is the aim of this work to employ cohesive zone models for the description of intergranular fracture and to derive a scaling law that ensures finite-element mesh independent cyclic traction-separation laws (TSL) under fatigue loading. This enables a detailed assessment of intergranular fatigue behavior within the framework of digital material twins. A mechanic cohesive zone model is developed that describes damage initiation and evolution depending on the grain boundary type. The cohesive properties of grain boundaries are derived from atomistic calculations under monotonic loading, and a scaling approach is evaluated to bridge the TSL from the atomistic to the macroscopic scale. The scaling approach of Möller et al. (2018) for bilinear TSL is generalized from simple atom pairs to specific grain boundary types under monotonic loading. To model fatigue crack growth, the TSL is extended to describe damage under fatigue loading using the exponential Xu-Needleman-TSL. The concepts of bilinear and the Xu-Needleman-TSL are analyzed in terms of their scaling behavior.

### **Blöchle, Jennifer:** A New Shape-Adaptive Robot Gripper Using Magnetorheological Fluids and Additively Manufactured Cylinders

Manipulating fragile objects of different shapes is a major robotics challenge. This led to the development and investigation of various gripper concepts with different flexible materials. This concept study focuses on the development of a shape-adaptive gripper that uses additively manufactured cylinders with variable heights and Shore hardness to achieve optimal adaptability and gripping force. The cylinders are filled with magnetorheological fluid (MRF), the properties of which are controlled by a standard electromagnet operating at 24 volts and 2 amps. The proposed concept aims to systematically investigate the influence of cylinder height, MRF volume, and material hardness on adaptability and gripping stability. Cylinders of varying heights allow for variations in MRF volume, enabling analysis of the fluid's volumetric behavior under the

influence of a magnetic field. The Shore hardness of the additively manufactured structures is incrementally adjusted to optimize the balance between flexibility and structural stability. The electromagnet stimulates the MRF, altering its viscosity and stiffness to enable effective adaptation to various object geometries. The concept combines the properties of flexible materials and active fluids in a modular design, making it relevant for diverse applications such as robotics and automation.

## **Domènech Monfort, Meritxell:** Investigating Synergies and Trade-offs Between Negative Emission Technologies and Hydrogen for Enhanced Energy System Flexibility: A Quantitative Analysis

As a first-year doctoral researcher, I would like to present the concept and structure of my PhD thesis, which explores the interactions between hydrogen deployment and negative emission technologies (NETs) in the energy system.

The core hypothesis of my research is that deploying NETs, specifically Bioenergy with Carbon Capture and Storage (BECCS) and pyrolysis, can offer a more cost-effective and environmentally sustainable solution for energy system flexibility than large-scale hydrogen expansion alone.

To test this hypothesis, I will use the open-source PyPSA-Eur energy system model. I plan to significantly enhance its capabilities by incorporating new technologies, enabling high regional resolution (NUTS-3), and integrating sectoral coupling with hydrogen. Key objectives include modelling BECCS, pyrolysis, and hydrogen infrastructure, implementing environmental and technical constraints, and adapting datasets for detailed regional analysis.

The research is structured into three interlinked studies:

- **Study 1:** Examines trade-offs between NETs and biomass availability.
- **Study 2:** Investigates hydrogen production, storage, and distribution, and their integration into the broader energy system.
- **Study 3:** Explores systemic interactions between hydrogen and NETs, identifying synergies and potential conflicts.

This presentation will give an overview of the research objectives, the motivation behind and the methodological framework.

## **Durán Guerra, Héctor Alfonso:** Valorization of insect-based chitin using enzymes

Chitin is one of the most abundant biopolymers on our planet, second only to cellulose. It can be found in the exoskeletons of crustaceans and insects, rendering it a readily available resource. Furthermore, the use of edible insects as a food source for humans has emerged as an issue of worldwide interest, due to global population growth, food insecurity in some regions of the world and increasing environmental pressures. Chitin is the primary feedstock for the production of the commercially relevant polymer chitosan as well as chitosan oligosaccharides (COS).

COS have potential applications in the biomedical, pharmaceutical and agricultural sectors due to their physicochemical properties and reactive functional groups.

Today, the production of chitosan and COS is achieved by chemical depolymerization and deacetylation reactions that provide limited control on product characteristics, demand substantial labor during downstream processing and have a negative environmental impact. Currently, there is no other commercial alternative for the conversion of chitin to chitosan.

This research project focuses on the development of an alternative to extract and process chitin from crustaceans and insects. An enzymatic platform to catalyze the depolymerization and deacetylation of chitin mediated by exo-chitinases, endo-chitinases and deacetylases to produce COS and chitosan. Exo-chitinases and endo-chitinases are hydrolytic enzymes that are able to convert chitin polysaccharides into shorter oligosaccharides, potentially increasing the accessibility of further enzymatic processing.

## **Gehringer, Alexander:** Resilience in Times of Polycrisis: A Dynamic Capability Perspective on Strategy, Innovation, and Leadership in German SMEs

Small and medium-sized enterprises (SMEs) are the backbone of many economies, particularly in Germany, where the *Mittelstand* plays a central role in employment and value creation. Yet, SMEs often operate under significant resource constraints, making them particularly vulnerable in times of external disruption. Starting with Covid-19, the convergence of global crises—such as geopolitical conflicts, war in Europe, supply chain disruptions, and a looming global recession—has triggered what many now refer to as a “polycrisis.” For SMEs, these interconnected challenges affect not only day-to-day operations but also long-term strategic positioning.

While short-term responses such as retrenchment or temporary business model adaptations can provide immediate relief, sustainable resilience requires more than survival. Research increasingly points to the strategic importance of innovation—particularly business model innovation—as a key lever for long-term success. Yet, for incumbent SMEs, making significant changes to established business models is tough. Deep-rooted routines, organisational inertia, and resistance to change frequently stand in the way.

This presentation shares insights from my doctoral research project, which investigates how established German SMEs navigate this era of ongoing disruption. Based on a qualitative multiple case study design and a series of semi-structured interviews, the study examines how these firms sense environmental change, seize strategic opportunities, and reconfigure their business models. The analysis is guided by a dynamic capability-based transmission framework, structured around a tripod perspective on strategy, innovation, and leadership.

What enables some traditional SMEs to transform in the face of disruption, while others remain trapped in survival mode? And how can leadership actively foster innovation in organisations that are inherently resistant to change? These are the key questions this talk will explore.

## **Guerra Nunez, Philip: A Framework for Hydrogen Infrastructure Analysis in Regional Energy Systems**

As a first-year doctoral researcher at the Offenburg University of Applied Sciences, I would like to present the concept and structure of my PhD thesis. The aim of my research is to develop a comprehensive framework to analyze the integration of hydrogen infrastructure into regional energy systems. This topic is particularly relevant given the technical and economic challenges posed by the transition to 100% renewable energy systems.

My methodology combines energy system modeling using MyPyPSA-Ger with grid simulation tools such as pandapower. The project is divided into three main phases:

1. **National Analysis:** The first phase focuses on expanding the MyPyPSA-Ger model to include hydrogen infrastructure for Germany. This includes evaluating pathways for hydrogen production, storage, and transport.
2. **Regional Analysis:** The second phase narrows the focus to a detailed analysis of the Südbaden region, considering cross-border energy exchanges with France and Switzerland, as well as local dynamics and potential hydrogen clusters.

3. Grid Simulation: The final phase evaluates the grid-level impacts of hydrogen technologies on flexibility and stability. These simulations use operational outputs from the regional MyPyPSA model as inputs.

This presentation will offer an overview of the research problem, the motivation behind it, and the methodological framework I plan to apply.

## **Lamm, Bianca:** Presentation of a Visual RAG Pipeline applied on Product Advertisements

Vision Language Models (VLMs) represent a major advancement in multi-modal Artificial Intelligence, combining visual and textual data processing. However, VLMs have mainly a knowledge about public available data. The Retrieval Augmented Generation (RAG) approach enhances access to external information.

In this talk, a Visual RAG Pipeline that merges the RAG approach with VLMs is presented. The pipeline involves five main steps: Preprocessing, Vector Store, Retrieval, Classification and Relational Query, Prompt Generation, and Completion. A custom dataset has been utilized for the evaluation of the pipeline. This dataset comprises image data depicting product advertisements as presented in leaflets, along with corresponding product and promotion information pertaining to the advertisements. Promotion data includes aspects such as price, regular price, and discounts, while product data covers attributes like brand, weight, and Global Trade Item Numbers (GTINs), with the GTIN serving as a standardized and unique identifier for products.

In the retail and supply chain domain, data related to GTINs are crucial for reporting and analysis. Given the constantly changing range of traded products, many of which are often highly similar, the Fine-Grained Classification (FGC) of these products is essential for effective analysis.

The task of FGC has been explored using the Visual RAG Pipeline. The comparison of various VLM back-ends, including GPT-4o, GPT-4o-mini, and Gemini 2.0 Flash, utilized within this pipeline, has yielded an accuracy rate of 86.8%.

## **Mas'udah:** Optimising AI-Driven Solutions Without Trade-offs: Predicting and Preventing Potential Failures in Sustainable Innovation

This presentation introduces a systematic approach to predict and prevent potential failures in AI-generated solution concepts for sustainable process innovation. Based on a paper prepared for the ICED 2025 Conference (to be presented in UT Dallas, 11–14 August 2025), the approach builds upon previous research combining generative AI with patent-

based evaluation to identify secondary problems and unintended consequences early in the design phase. Applying this method makes it possible to enhance the feasibility and sustainability of AI-driven innovations. The talk will briefly outline the methodology and showcase a case study from nickel recovery using froth flotation. The goal is to contribute to the discussion around responsible and anticipatory innovation using AI tools in early-stage development.

## **Rehorst, Sebastian:** Is there such a thing as the perfect 400m runner?

*What biomechanics reveal about sprint endurance*

What makes a successful 400-metre sprinter? Is it stride length, acceleration, stamina - or all of the above? In my doctoral project, I am looking for biomechanical characteristics that can explain performance in the long sprint.

I am particularly interested in an area that has been little studied to date: **sprint endurance** - the ability to maintain a very high running speed for as long as possible. I am analyzing how movement patterns, forces and stride parameters change over the course of the race.

Measurements are taken using a motion capture system, high-speed cameras and high-tech software - like those used in animated films. The aim is to make movement strategies visible and to understand how successful athletes deal with the onset of fatigue.

The results should not only serve science, but also help trainers and athletes: in technique training, in diagnostics or to better prevent overuse.

Because perhaps there is no such thing as the perfect run. But there are ways to find the individual optimum.

### **Gibt es den perfekten 400m-Läufer oder die perfekte 400m-Läuferin?**

*Was die Biomechanik über Sprintausdauer verrät*

Was macht einen *erfolgreichen* 400-Meter-Sprinter\*in aus? Ist es die Schrittlänge, der Antritt, das Durchhaltevermögen – oder alles zusammen? In meinem Promotionsprojekt suche ich nach biomechanischen Merkmalen, die die Leistung im Langsprint erklären können.

Dabei interessiert mich besonders ein bislang wenig untersuchter Bereich: die **Sprintausdauer** – also die Fähigkeit, eine sehr hohe Laufgeschwindigkeit möglichst lange aufrechtzuerhalten. Ich analysiere, wie sich Bewegungsmuster, Kräfte und Schrittparameter über den Rennverlauf verändern.

Gemessen wird mit Motion-Capture-System, Hochgeschwindigkeitskameras und High-Tech-Software – wie man sie auch aus Animationsfilmen kennt. Ziel ist es, Bewegungsstrategien sichtbar zu machen und zu verstehen, wie erfolgreiche Athlet\*innen mit der einsetzenden Ermüdung umgehen.

Die Ergebnisse sollen nicht nur der Wissenschaft dienen, sondern auch Trainerinnen und Sportlerinnen helfen: beim Techniktraining, in der Diagnostik oder um Überlastungen besser vorzubeugen.

Denn vielleicht gibt es ihn nicht – den *einen* perfekten Lauf. Aber es gibt Wege, das individuelle Optimum zu finden.

### **Roth, Sebastian:** Asymmetric hearing provisions and the resulting challenges for spatial hearing

Our research group focuses on investigation of spatial hearing in asymmetrical hearing losses that are treated with different hearing provisions in both ears. For example, when a hearing aid is used in conjunction with a normal hearing ear or a cochlear implant. Our results show that precise interaural alignment in the temporal and spectral domain is necessary to improve spatial hearing. In particular, compensating for differences in the processing delays of the devices seems to be a promising approach to improve spatial hearing abilities, such as sound localization and speech understanding in noisy environments.

### **Sandhaas, Anna:** Flexible, Climate-Friendly, Underestimated: Pyrolysis as a Key Technology by 2050

Presentation optionally in English or German

#### **Flexibel, klimafreundlich, unterschätzt: Pyrolyse als Schlüsseltechnologie bis 2050**

Deutschland verfolgt das ambitionierte Ziel, bis 2045 klimaneutral zu werden. Dabei wird deutlich, dass neben der umfangreichen Reduktion von Treibhausgasemissionen auch Technologien zur Entfernung von CO<sub>2</sub> aus der Atmosphäre, sogenannte Negative Emission Technologies (NETs), unverzichtbar sind. Während auf diesem Forschungsgebiet zahlreiche Ansätze existieren, nimmt die Pyrolyse eine besondere Stellung ein, da sie neben der Kohlenstoffspeicherung in Biochar auch flexibel einsetzbare Energieprodukte wie Pyrolysegas und -öl erzeugen kann.

Bisherige Studien konzentrieren sich vor allem auf die CO<sub>2</sub>-Senkenfunktion der Pyrolyse, also die langfristige Kohlenstoffbindung im Biochar, oder auf die Substitution fossiler Energieträger durch pyrolytische Produkte. Die Rolle der Pyrolyse als eigenständiger Stromerzeuger und deren Integration in das Energiesystem wurde bislang kaum

untersucht. Dies ist eine bedeutende Forschungslücke – insbesondere vor dem Hintergrund steigender Stromnachfrage durch Sektorenkopplung, wie der Elektrifizierung der Industrie, des Verkehrs und der Wärmeversorgung.

Unsere Forschungsarbeit adressiert diese Lücke, indem wir Pyrolyse erstmalig als Technologie mit dualen Nutzen – CO<sub>2</sub>-Entnahme und flexible Stromerzeugung – in ein detailliertes Energiesystemmodell integrieren. Wir analysieren dabei nicht nur die Auswirkungen auf die Kraftwerksstruktur und Speicherinfrastruktur in Deutschland bis 2050, sondern berücksichtigen auch regionale Ressourcenverteilung sowie wirtschaftliche Rahmenbedingungen wie Investitionskosten und Marktnachfrage.

Die Ergebnisse zeigen, dass Pyrolyse bis 2050 ein installierter Leistungsträger mit etwa 5 GW werden kann und rund 2 % des Strombedarfs deckt. Durch ihre flexible Stromerzeugung reduziert sie die Abhängigkeit von Wasserstoffspeichern erheblich, da sie in Zeiten niedriger erneuerbarer Einspeisung einspringt. Gleichzeitig ermöglicht die Biocharspeicherung negative Emissionen und erlaubt so den kontinuierlichen Betrieb bestehender Gaskraftwerke bei Netto-Null-CO<sub>2</sub>-Bilanz. Die Pyrolyse erweitert somit nicht nur die CO<sub>2</sub>-Entfernungskapazitäten, sondern stabilisiert als innovative Technik das zukünftige erneuerbare Energiesystem.

Diese Arbeit liefert wichtige Impulse, um politische Fördermechanismen und Investitionsstrategien für die Energiewende weiterzuentwickeln und zeigt das Potenzial einer Technologie, die negative Emissionen und erneuerbare, steuerbare Energie intelligent kombiniert.

## **Zandomeni, René:** Digital Material Twins for Assessing Local Fatigue Damage in Duplex Steels

Duplex steels (DS) combine the excellent mechanical properties of ferrite with the corrosion resistance of austenite and are used for components exposed to fatigue loading, such as offshore equipment. The cyclic behavior of DS is influenced by the properties of the two phases, their volume fractions, and their crystallographic orientations, which lead to varying degrees of incompatibility in deformation within the microstructure. This results in fatigue cracks that can form both within each phase and along the phase boundaries.

In the context of a digital material twin, Fatigue Indicator Parameters (FIPs) are used to assess the microstructure-dependent initiation of fatigue cracks and early crack growth. FIPs, in the context of crystal plasticity, are derived from finite element simulations based on models of real microstructures. These simulations provide surface-specific insights into localized phenomena associated with fatigue.

This work enables the detailed fatigue life assessment of duplex steels with digital material twins.

## Materials for the colloquium

Please fill out the [feedback form](#) for the colloquium to help support its further development. The survey consists of 11 questions and takes approximately 2 to 5 minutes. Please note that the survey will be open until July 31st. Thank you very much for your participation!



*Abbildung 1: QR-Code to the feedback form*