

# Khalil Al Handawi

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## PROFILE

<b>Research</b>	Design under uncertainty, additive manufacturing, multidisciplinary design optimization, and decision making using agent-based modeling
<b>Technical</b>	
ENGINEERING SYSTEMS	- Design for changeability and reliability, uncertainty quantification - Analysis and allocation of design margins
MODELING AND SIMULATION:	- Finite element methods (thermomechanical, structural, electromagnetic) - Agent-based methods, system dynamics models
OPTIMIZATION:	- Blackbox and derivative-free optimization (mesh-adaptive direct search) - Stochastic optimization
MACHINE LEARNING:	- Deep learning (recurrent neural networks) - Hyperparameter optimization
<b>Software</b>	MATLAB/Simulink, Python (pandas, PyTorch, matplotlib, flask), C++ (CUDA, OpenMP, Qt) R (ggplot2, tidyverse), mySQL, FEA (Abaqus, ANSYS), CAD (SOLIDWORKS, NX Siemens), DAQ (NI LabVIEW)

## EDUCATION

JAN 2017 – DEC 2020	<b>Doctor of Philosophy</b> Mechanical Engineering , CGPA: 4.00 Engineering design and optimization <i>Optimization driven set-based design under uncertain requirements</i>	<i>McGill University</i>
AUG 2013 – DEC 2015	<b>Master of Science</b> Mechanical Engineering , CGPA: 4.00 Instrumentation and photonics <i>Internal corrosion detection of oil and gas pipelines using fiber optics</i>	<i>Khalifa University</i>
AUG 2009 – JUNE 2013	<b>Bachelor of Science</b> Mechanical Engineering , FIRST CLASS HONOURS, CGPA: 3.97 <i>Development of a human operated mobile hexapod platform</i>	<i>Khalifa University</i>

## EXPERIENCE

MAY 2022 – PRESENT	<b>Computer Science and Operations Research, Université de Montréal</b> MONTRÉAL, CANADA <i>Postdoctoral Researcher</i> <ul style="list-style-type: none"><li>• Won a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship to pursue research at UdeM.</li><li>• Work with the International Air Transport Association (IATA) to develop data analytics solutions for codesharing and flight scheduling in the civil aviation industry.</li><li>• Assess the effectiveness and impact of the IATA operation safety audit (IOSA) on air travel accessibility and cooperation between airlines.</li><li>• Construct a mariaDB mySQL database for storing flight records spanning the last decade for research purposes.</li><li>• Leverage unsupervised learning and expectation maximization algorithms to discover latent variables in the IATA dataset using R, Python, and Julia packages.</li></ul>	
SEP 2022 – DEC 2022	<b>Department of Mechanical Engineering, McGill University</b> MONTRÉAL, CANADA <i>Adjunct Lecturer</i>	

- Was the sole instructor of the Engineering System Optimization course (MECH559).
- Developed Python notebooks as teaching aids for the students to understand the implementation of modern optimization algorithms [https://github.com/khbalhandawi/MECH559\\_notebooks](https://github.com/khbalhandawi/MECH559_notebooks).
- Modernized the course to use the latest optimization and machine learning tools.

SEP 2021 – DEC 2021

**Systems Engineering Design Lab, Chalmers University of Technology** GÖTEBORG, SWEDEN  
*Postdoctoral Researcher*

- Integrate my doctoral research on design under uncertainty into the activities of the SED lab.
- Authored a Python library for performing margin and change propagation management in engineering systems: <https://sed-group.github.io/mvmlib/index.html>.
- Conduct research into design margins and links to probabilistic quantities such as reliability.
- Foster collaborations with the industry (GKN Aerospace) and write research proposals.

JAN 2021 – APR 2022

**Systems Optimization Lab, McGill University**

MONTRÉAL, CANADA

*Postdoctoral Researcher*

- Developed a deep learning forecasting model for COVID-19 trajectories based on cross-sectional patient data. The forecasting model is a sequence-to-sequence model that uses encoder and decoder RNNs with attention to transform cross-sectional patient data to a COVID-19 trajectory.
- Deployed the trained forecasting model online as a Flask application: <https://covid-forecaster-lebanon.herokuapp.com/>.
- Applied novel stochastic optimization techniques for hyperparameter optimization problems in machine learning and used them to fine tune the sequence-to-sequence model.
- Built and published a stochastic model of the spread of COVID-19 in a population using artificial life models (agent-based approaches) and used stochastic optimization algorithms to solve for optimal public health policies [https://github.com/khbalhandawi/COVID\\_SIM\\_GPU](https://github.com/khbalhandawi/COVID_SIM_GPU).
- Lectured the engineering systems optimization class and developed MATLAB training modules and projects related to multidisciplinary optimization (NoHiMDO) with applications to aircraft design.

JAN 2017 – JAN 2021

**McGill University**

MONTRÉAL, CANADA

*Research assistant*

- Won a Fonds de Recherche du Québec Nature et Technologie (FRQNT) grant (56,000 CAD).
- Developed mathematical frameworks for quantifying design flexibility and robustness and managing uncertain requirements in aircraft system and subsystem design.
- Developed a thermomechanical simulation model for modeling additive manufacturing repair and life extension processes using transient coupled thermal/mechanical FEA simulations.
- Write automation scripts using NX Siemens and Abaqus Python APIs to automate geometry generation, meshing, analysis, and postprocessing of parametric simulations.
- Co-developed a novel lifecycle cost model based on system dynamics to model the effect of life extension on lifecycle costs.
- Used machine learning models to substitute expensive thermomechanical simulations in design studies and developed a variant of kernel smoothing for estimating the sensitivity of design solutions to different requirements by using a Jacobian matrix.
- Authored a Flask application for conducting sensitivity and scalability studies on design of experiments data: [https://github.com/khbalhandawi/scale\\_AM\\_webapp](https://github.com/khbalhandawi/scale_AM_webapp).

JUNE 2017 – JAN 2020

**GKN Aerospace Engine Systems**

TROLHÄTTAN, SWEDEN

*Visiting researcher*

- Participated in a technology transfer to translate my research on optimization into industrial practice by provided training modules and workshops to GKN engineers (MATLAB and Python).
- Surveyed GKN engineers about their experience designing aeroengine components for engine system manufacturers to create a timeline of expected design updates and changes. This data formed the basis of a case study for my research on design for flexibility and robustness.

- Set up advanced design automation and exploration tools to be used as part of GKN's workflow (engineering workbench) by integrated parametric design software (NX Siemens) with simulation software (Abaqus and ANSYS) to evaluate hundreds of concepts for a turbine rear frame.

DEC 2016     **Center for Autonomous Robotic Systems, Khalifa University**     ABU DHABI, UAE  
*Visiting researcher*

- Performed sensor fusion research for unmanned aerial vehicle (UAV) control and maneuvering.
- Fused UAV inertial measurement unit (IMU) data with high latency positioning measurements from an Optitrack motion capture system to obtain smooth high frequency attitude estimates suitable for control applications.
- Used the principles of quaternion transformation to translate observed attitude in the IMU reference frame to an inertial reference frame.
- Repurposed a DJI Wind 4 UAV for firefighting by redesigning the drone platform to carry an extinguishant payload.
- Co-authored a paper based on the repurposed UAV to be published in a special issue of the Journal of Field Robotics.

AUG 2013 – DEC 2016     **Asset Integrity Management Systems Lab, Khalifa University**     ABU DHABI, UAE  
*Research Assistant*

- Developed fiber optic sensors for monitoring mechanical and electrochemical phenomena such as strain, temperature, and corrosion.
- Used optical time-domain reflectometry for distributed fiber optic sensing of large structures such as oil pipelines.
- Worked with fiber Bragg grating sensors for localized measurements of strain and temperature and their subsequent translation into corrosion rate.
- Established a correlation between photoelastic properties of various waveguides (distributed and localized sensors) and the corrosion rate in oil and gas structures.
- Simulated photonic corrosion sensors in MATLAB and Abaqus for sensor design and calibration.
- Developed a novel accelerated corrosion testing setup based on electrochemical cells for validating and verifying the proposed corrosion sensors and establishing the calibration curve.

MAY 2014 – MAY 2015     **Khalifa University**     ABU DHABI, UAE  
*Khalifa university Baja SAE team leader*

- Led the first UAE national team to compete in the Baja SAE competition (Maryland, 2015).
- Guided the assembly team on integrating vehicle subsystems (chassis, suspension, and power train).
- Performed structural optimization on vehicle chassis using MATLAB and ANSYS.
- Provided workshops on finite element analysis and computer aided design to team members.
- Prepared assembly and part drawings for the manufacturing team.

JAN 2018 – DEC 2019     **McGill University**     MONTRÉAL, CANADA  
*Teaching assistant*

- Mechanical lab course – Prepared lab manuals, conducted labs, graded student reports, and incorporated MATLAB programming exercises into the syllabus.
- Engineering Professional Practice course – Conducted town halls, hosted guest lecturers, provided feedback to students, and gave several talks about entrepreneurship.

AUG 2013 – DEC 2015     **Khalifa University**     ABU DHABI, UAE  
*Teaching Assistant*

- System dynamics and controls course – Conducted lab sessions and held office hours.
- Computer aided design – Conducted computer lab sessions.
- Mentored undergraduate students participating in the Abu Dhabi Solar Challenge.
- Co-mentored an undergraduate capstone project.

AUG 2012 – MAY 2012	<b>Yokogawa</b> <i>Engineering intern</i>	ABU DHABI, UAE
	<ul style="list-style-type: none"> <li>Wrote programs for industrial plant operation and control using distributed control systems.</li> <li>Visited the main headquarters in Japan to represent the Abu Dhabi National Oil Company.</li> </ul>	

## AWARDS AND RECOGNITION

MAY 2022 – APR 2024	<b>Postdoctoral fellowship (PDF)</b> <i>National Sciences and Engineering Research council Canada</i>	90,000 CAD
MAY 2019 – DEC 2021	<b>Doctoral Research award (B2X)</b> <i>Fonds de Recherche du Québec - Nature et Technologies</i>	56,000 CAD
JAN 2017 – DEC 2019	<b>McGill Engineering Doctoral Award (MEDA)</b> <i>McGill University</i>	96,000 CAD
AUG 2013 – DEC 2015	<b>ADNOC Graduate fellowship</b> <i>Abu Dhabi National Oil Company</i>	90,000 USD
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Our <a href="#">paper on scalable designs</a> was selected for the 2021 ASME Journal of Mechanical Design Editor's Choice award		ASME IDETC 2022, ST. LOUIS, USA
Awarded 2nd place for final problem presentation and winner of best data visualization in the 11th Montreal Industreal Problem Solving Workshop		IVADO, MONTREAL, CANADA
Team leader of the first UAE team to successfully qualify and complete the Baja SAE competition		KHALIFA UNIVERSITY, ABU DHABI, UAE
Awarded 2nd place in the Abu Dhabi Solar Challenge (10,000 AED)		KHALIFA UNIVERSITY, ABU DHABI, UAE
Recognition for volunteering for the graduate School and student affair's events		KHALIFA UNIVERSITY, ABU DHABI, UAE
Graduated honors with distinction (2,000 AED)		KHALIFA UNIVERSITY, ABU DHABI, UAE

## PUBLICATIONS

### Refereed Journal Articles

- A. Khalil, **K. Al Handawi**, Z. Mohsen, A. Abdel Nour, R. Feghali, I. Chamseddine and M. Kokkolaras (2022). Weekly nowcasting of new COVID-19 cases using past viral load measurements. *Viruses*, 14(7): pp 1414. doi: [10.3390/V14071414](#)
- K. Al Handawi** and M. Kokkolaras (2021). Optimization of infectious disease prevention and control policies using artificial life. *IEEE Transactions on Emerging Topics in Computational Intelligence*, doi: [10.1109/TETCI.2021.3107496](#) funded by an NSERC discovery grant
- K. Al Handawi**, M. Panarotto, P. Andersson, O. Isaksson and M. Kokkolaras (2021). Optimization of design margins allocation when making use of additive remanufacturing. *Journal of Mechanical Design*, 144(1): pp 012001. doi: [10.1115/1.4051607](#) funded partially by NSERC, FRQNT, CARIC and EU Horizon 2020 research and innovation programme
- M. Chehadeh, M. Wahbah, M. Awad, O. AbdulHay, **K. Al Handawi**, L. Seneviratne, I. Greatbatch and Y. Zweiri (2021). Novel aerial firefighting system for suppression of incipient cladding fires. *Journal of Field Robotics*, (In Press) funded by Emaar Properties PJSC
- K. Al Handawi**, P. Andersson, M. Panarotto, O. Isaksson and M. Kokkolaras (2020). Scalable set-based design optimization and remanufacturing for meeting changing requirements. *Journal of Mechanical Design*, 143(2): pp 021702. doi: [10.1115/1.4047908](#) funded partially by NSERC, FRQNT, CARIC and EU Horizon 2020 research and innovation programme
- K. Al Handawi**, N. Vahdati, O. Shirayayev and L. Lawand (2017). Analytical modeling tool for design of hydrocarbon sensitive optical fibers. *Sensors*, 17(10): pp 2227. doi: [10.3390/s17102227](#) funded by Abu Dhabi National Oil Company

L. Lawand, O. Shirayayev, **K. Al Handawi**, N. Vahdati and P. Rostron (2017). Corrosivity sensor for exposed pipelines based on wireless energy transfer. *Sensors*, 17(6): pp 1238. doi: [10.3390/s17061238](https://doi.org/10.3390/s17061238)  
funded by Abu Dhabi National Oil Company

**K. Al Handawi**, N. Vahdati, P. Rostron, L. Lawand and O. Shirayayev (2016). Strain-based FBG sensor for real-time corrosion rate monitoring in pre-stressed structures. *Sensors and Actuators B: Chemical*, 236: pp 276 – 285. doi: [10.1016/j.snb.2016.05.167](https://doi.org/10.1016/j.snb.2016.05.167)  
funded by Abu Dhabi National Oil Company

## Conference Papers

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**K. Al Handawi**, P. Andersson, M. Panarotto, O. Isaksson and M. Kokkolaras (2020). Scalable set-based design optimization and remanufacturing for meeting changing requirements. in *Proceedings of the International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*, Virtual conference, IDETC2020.

L. Lawand, **K. Al Handawi**, M. Panarotto, P. Andersson, O. Isaksson and M. Kokkolaras (2019). A lifecycle cost-driven system dynamics approach for considering additive re-manufacturing or repair in aero-engine component design. in *Proceedings of the Design Society: International Conference on Engineering Design*, Delft, Netherlands, ICED19: pp 1343 – 1352. doi: [10.1017/dsi.2019.140](https://doi.org/10.1017/dsi.2019.140)

**K. Al Handawi**, N. Vahdati, O. Shirayayev, and L. Lawand (2016). Corrosion monitoring along infrastructures using distributed fiber optic sensing. in *Proceedings of SPIE Smart Structures/NDE, International Society for Optics and Photonics, Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems*, Las Vegas, USA, SPIE2016. doi: [10.1117/12.2218820](https://doi.org/10.1117/12.2218820)

L. Lawand, O. Shirayayev, **K. Al Handawi**, N. Vahdati and P. Rostron (2016). Corrosivity monitoring system using RFID-based sensors. in *Proceedings of SPIE Smart Structures/NDE, International Society for Optics and Photonics, Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems*, Las Vegas, USA, SPIE2016. doi: [10.1117/12.2218813](https://doi.org/10.1117/12.2218813)

## COURSE WORK

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|------------------------------------|----------------------------------------|
| • Advanced mechanics of materials  | • Material engineering and corrosion   |
| • Engineering systems optimization | • Measurements and instrumentation     |
| • Continuum mechanics              | • Advanced vibrations                  |
| • Applied numerical methods        | • Fracture mechanics                   |
| • Applied finite element analysis  | • Viscous and compressible fluid flows |

## PERSONAL INTERESTS

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| • Gymnastics and calisthenics training | • 3D printing hobbyist                               |
| • Powerlifting                         | • Car modding (muscle cars) and drag racing          |
| • Competitive gaming                   | • Tinkering/modifying any machine I get my hands on! |