Khalil Al Handawi, PhD

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EDUCATION

JAN 2017 – DEC 2020 **Doctor of Philosophy** *McGill University*
Mechanical Engineering , CGPA: 4.00
CONCENTRAION Engineering design and optimization
DISSERTATION *Optimization driven set-based design under uncertain requirements*

AUG 2013 – DEC 2015 **Master of Science** *Khalifa University*
Mechanical Engineering , CGPA: 4.00
CONCENTRAION Instrumentation and photonics
DISSERTATION *Internal corrosion detection of oil and gas pipelines using fiber optics*

AUG 2009 – JUNE 2013 **Bachelor of Science** *Khalifa University*
Mechanical Engineering , FIRST CLASS HONOURS, CGPA: 3.97
CAPSTONE PROJECT *Development of a human operated mobile hexapod platform*

WORK EXPERIENCE

Research

MAY 2022 – PRESENT Department of Computer Science and Operations Research, Université de Montréal — MONTRÉAL, CANADA
Postdoctoral Researcher

- Won a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship to pursue research at UdeM.
- Work with the International Air Transport Association (IATA) to develop data analytics solutions for codesharing and flight scheduling in the civil aviation industry.
- Assess the effectiveness and impact of the IATA operation safety audit (IOSA) on air travel accessibility and cooperation between airlines.

JAN 2021 – APR 2022 Systems Optimization Lab, McGill University — MONTRÉAL, CANADA
Postdoctoral Researcher

- Developed a deep learning now-casting model for COVID-19 trajectories based on cross-sectional patient data.
- Applied novel stochastic optimization techniques for hyperparameter optimization problems in machine learning.
- Built and published a stochastic model of the spread of COVID-19 in a population using agent-based approaches to identify optimal public health policies.

SEP 2021 – DEC 2021 Systems Engineering Design Lab, Chalmers University of Technology — GÖTEBORG, SWEDEN
Postdoctoral Researcher

- Integrate my doctoral research (design under uncertainty) into SED lab activities.
- Develop a design margins library for engineering change propagation management.
- Research design margins and links to probabilistic quantities(reliability).
- Foster collaboration with industry (GKN Aerospace) and write research proposals.

JAN 2017 – JAN 2021 McGill University — MONTRÉAL, CANADA
Research assistant

- Awarded Fonds de Recherche du Québec (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, anaylsis, 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.

JAN 2016 – JAN 2017 — Asset Integrity Management Systems Lab, Khalifa University — ABU DHABI, UAE

Research Assistant

- Developed corrosion monitoring devices and software that helped offset pipeline maintenance costs.
- Developed a wide range of fiber optic sensors that cost a fraction of their electrical counterparts.

Industry

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 areoengine 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.

AUG 2012 – MAY 2012 — Yokogawa — ABU DHABI, UAE

Engineering intern

- Created software and programs for industrial plant operation and control using Distributed Control Systems.
- Visited the main headquarters in Japan to represent the Abu Dhabi National Oil Company.

Management

JAN 2021 – PRESENT — BPGIC holdings Limited — DUBAI, UAE
Non-executive independent member of board of directors
- Make decisions on the BPGIC holdings Limited board of directors to further the company's objective of expanding its operations in the energy sector.
- Attend quarterly board of directors meetings and provide expert opinion and advice.

JAN 2017 – PRESENT — Systems Optimization Lab, McGill University — MONTRÉAL, CANADA
Website manager
- Update the lab's website and disseminate new research to the public.
- http://www.sol.research.mcgill.ca/.

JAN 2014 – AUG 2015 — Solar car project, Khalifa University — ABU DHABI, UAE
Maintenance and procurement manager
- Designed a cutting edge engineering workshop for building and maintaining electric solar vehicles.

JUN 2011 – MAY 2013 — Baja SAE team, Khalifa University — ABU DHABI, UAE
Project team manager
- Was elected to lead the team during the Baja SAE 2013 and 2015 international competitions.
- Saw the project to completion and was recognized for leading the first UAE national team to participate in the Baja SAE competition.

TEACHING AND SUPERVISION

Teaching

JAN 2021 – APRIL 2021	Lectured the engineering systems optimization class (MEHC 559) and developed MATLAB training modules and projects related to multidisciplinary optimization (NoHiMDO) with applications to aircraft design.	MCGILL UNIVERSITY, MONTRÉAL, CANADA
SEP 2018 – DEC 2019	Teaching assistant for the mechanical lab (MECH 362) course for 3 semesters – prepared lab manuals, conducted labs, graded student reports, and provided feedback.	MCGILL UNIVERSITY, MONTRÉAL, CANADA
JAN 2018 – MAY 2018	Teaching assistant for the Engineering Professional Practice (FACC 400) course for 1 semester – Conducted town halls, substituted lecturers, and provided feedback to students.	MCGILL UNIVERSITY, MONTRÉAL, CANADA
JAN 2014 – MAY 2014	Teaching assistant for the System dynamics and controls course (including preparing lab sessions, office hours for students and grading midterm examinations). The TA duties also included conducting lab sessions (Transient systems and multiple degree of freedom systems).	KHALIFA UNIVERSITY, ABU DHABI, UAE
SEP 2013 – DEC 2013	Teaching assistant for the computer aided design course. Conducted computer lab sessions where students were taught CAD basics and guidelines for producing professional engineering drawings.	KHALIFA UNIVERSITY, ABU DHABI, UAE
SEP 2012 – MAY 2013	Grader for the Physics II undergraduate course. Graded student assignments, midterms and final examinations.	KHALIFA UNIVERSITY, ABU DHABI, UAE

Supervision

JAN 2016 – JAN 2017 — ***Asset Integrity Management Systems Lab, Khalifa University*** — ABU DHABI, UAE

- Student name: Safieh Almahmoud (Masters student)
  Affiliation: Khalifa University
  Domain: Solid mechanics, instrumentation, and photonics
- Student name: Tasneem Osman (Masters student)
  Affiliation: Khalifa University
  Domain: Solid mechanics, instrumentation, and acoustics

JAN 2014 –- AUG 2015 ***Senior graduation project, Khalifa University*** ABU DHABI, UAE

- Student name: Yazan Hindawi (Bachelors student)
  Affiliation: Khalifa University
  Domain: Solid mechanics, instrumentation, and robotics
- Student name: Ali Shamlan (Masters student)
  Affiliation: Khalifa University
  Domain: Solid mechanics, instrumentation, and robotics

DESCRIPTION OF SELECTED PUBLICATIONS

"Scalable set-based design optimization and remanufacturing for meeting changing requirements"

How do you quantify the remanufacturability of a product before it goes into production?

This question was motivated by the advent of novel manufacturing technologies such as additive manufacturing (AM) and their enormous potential to enable a circular economy recovery activities such as remanufacturing. In this paper, I highlight this potential and answer the above research question by using quantitative metrics to measure the design's remanufacturability when using additive or conventional subtractive manufacturing processes.
The metric was derived from the principle of design changeability, and the concept of scalability specifically. It was found that scalability is relevant to remanufacturing as it defines the potential for restoring product specifications to its original or better-than-original levels. I mathematically formulated a metric for scalability and used it in design space exploration (DSE) of an aeroengine component at GKN Aerospace engine systems to identify a set of scalable designs that are eligible for remanufacturing via additive manufacturing. The results show great promise and allow designers to incorporate the principles of sustainable manufacturing and design early in the product development cycle.

`python` `MATLAB` `NX Siemens` `Abaqus` `Thermomechanical simulation` `Design space exploration (DSE)` `Surrogate modeling` DOI: 10.1115/1.4047908

"Optimization of design margins allocation when making use of additive remanufacturing"

How do you design a component when the design requirements can change at any moment and without advance notice?

That is the question my dissertation tries to answer. To answer this question, I needed to identify the mechanisms by which products are able to mitigate requirement changes. The literature suggested passive methods such as the use of design margins and active methods such as changing the product's design. Each method has its advantages and disadvantages and balancing the two strategies within a product is key to cost-effective mitigation of changing requirements. I assessed different aeroengine product designs (from GKN aerospace) against a wide variety of requirement change scenarios (using Monte Carlo simulation) to identify those designs that absorbed the most change without negatively impacting the product's performance (in terms of weight and redesign cost). The results of the study show promise and the open-source design tool that was developed allows designers to conceive of lean products despite the uncertain design requirements they have to work with.

`python` `C++` `MATLAB` `R` `NX Siemens` `Abaqus` `Monte Carlo simulation` `Uncertainty quantification` Online open-source code DOI: 10.1115/1.4051607

"Optimization of Infectious Disease Prevention and Control Policies Using Artificial Life"

How can we apply the principles of design and decision making to help bring the pandemic under control?

Although this project is not directly relevant to the discipline of materials science and industrial engineering, I found it quite useful for my design research. This is because most design problems involve a fair bit of uncertainty at all stages of the product development process. Being able to explore the design space under uncertainty is a very challenging problem mathematically. This project exemplifies such design problems by treating the public health policies for an epidemic as design solutions.
I modeled how an infectious disease spreads in a small population. Diseases such as COVID-19 spread through social interaction. I programmed intelligent agents to model a complex social system. I used stochastic derivative-free optimization to determine the critical amount of intervention necessary to keep the disease in check without negatively affecting the economy. I used the stochastic optimization algorithm to reduce the number of hospitalizations beneath the healthcare capacity while reducing the socio-economic cost of interventions by up to **5 times** compared to a complete lock-down. Such tradeoffs are quite common in the engineering design world and I plan to use stochastic design exploration strategies in my future design research.

`C++` `CUDA` `python` `Qt` `Stochastic optimization` `Agent-based modeling` Online open-source code DOI: 10.1109/TETCI.2021.3107496

"A lifecycle cost-driven system dynamics approach for considering additive re-manufacturing or repair in aero-engine component design"

How can we minimize the lifecycle cost when considering additve remanufactuing life extension strategies?

I collaborated with a colleague that developed a novel lifecycle cost (LCC) model based on system dynamics to capture the causal loops that often arise in LCC modeling. Such casual loops include viscous cycles, where increasing one parameter leads to another increasing which in turn results in the former parameter increasing even more. Such loops are difficult to capture in traditional time-driven activity-based LCC modeling and hence the need for a system dynamics model. The developed LCC model was used to explore different life extension strategies for aeroengine products from an LCC perspective. I formulated and solved an optimization problem that captures the tradeoff between life extension strategies that favor "design for-life" versus strategies that favor frequent life extension and maintenance. Me and my colleague managed to present a tool for obtaining the optimal life extension schedule such that LCC is minimized.

`MATLAB` `Simulink` `Lifecycle cost (LCC)` `System dynamics modeling` DOI: 10.1017/dsi.2019.140

"Strain based FBG sensor for real-time corrosion rate monitoring in pre-stressed structures"
Oil pipelines are monitored for corrosion on regular intervals using conventional tools. This activity accrues massive maintenance costs on the pipeline operator. I tried to mitigate maintenance costs by developing a passive realtime corrosion monitoring product. This research was my first exposure to the industrial world and the importance of developing cost-effective solutions. Furthermore, this was my first real product-design problem, where I employed the principles of product development to arrive at a prototype solution that the industry can readily test. I used concept elimination to find a solution that best fulfils the requirements of oil pipeline operators of being intrinsically safe and requiring minimal energy to operate. I arrived at a concept that uses fiber optics to transmit and receive signals from the pipeline without needed much energy to excite the laser and posing no electrical hazards to the pipeline environment. This sensor consists of fiber Bragg grating (FBG), which is used to sense the change in the pipeline's hoop stress as a result of internal corrosion and localized thinning of its inner diameter. The system was simulated, and a laboratory scale prototype was 3D printed to validate and test the solution. Our setup featured advanced fiber optic sensors (fiber Bragg grating (FBG)) and spectral analyzers controlled and operated by LabVIEW data acquisition software. I also relied heavily on MATLAB and Abaqus simulations to construct and verify the setup.

`LabVIEW` `Abaqus` `MATLAB` `Fiber Bragg grating (FBG)` DOI: 10.1016/j.snb.2016.05.167

PUBLICATIONS

Submitted preprints

A. Khalil, **K. Al Handawi**, Z. Mohsen, A. Abdel Nour, R. Feghali, I. Chamseddine and M. Kokkolaras (2021). Predicting COVID-19 incidences from patients' viral load using deep-learning. *medRxiv* doi: 10.1101/2021.08.14.21262064

Refereed Journal Articles

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. Shiryayev 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. Shiryayev, **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
funded by Abu Dhabi National Oil Company

K. Al Handawi, N. Vahdati, P. Rostron, L. Lawand and O. Shiryayev (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
funded by Abu Dhabi National Oil Company

Refereed Conference Papers

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

K. Al Handawi, L. Lawand , P. Andersson, R. Brommesson, O. Isaksson and M. Kokkolaras (2018). Integrating additive manufacturing and repair strategies of aeroengine components in the computational multi-disciplinary engineering design process. *in Proceedings of NordDesign*, Linköping, Sweden, NordDesign 2018.

K. Al Handawi, N. Vahdati, O. Shiryayev, 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

L. Lawand, O. Shiryayev, **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

Poster presentations

K. Al Handawi, P. Andersson, O. Isaksson and M. Kokkolaras (2019). Scalable set-based design solutions for product remanufacturing. *International Conference on Engineering Design*, Delft, Netherlands, ICED19.

K. Al Handawi, L. Lawand, T. Hitchcox, Y. F. Zhao and M. Kokkolaras (2018). Additive manufacturing optimization and simulation platform for repairing and remanufacturing of aerospace components. *CRIAQ RDV Forum*, Montréal, Canada.

RESEARCH INTERESTS

- Artificial intelligence in engineering design
- Design for changing requirements
- Robust design
- Reliability
- Numerical simulation
- Systems optimization
- Surrogate modelling
- Stochastic programming
- Derivative-free optimization
- Computer aided design
- Computer aided engineering
- Manufacturing

COURSE WORK

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

AWARDS AND RECOGNITION

MAY 2022 – APR 2024	**Postdoctoral fellowship (PDF)**	90,000 CAD
	National Sciences and Engineering Research council Canada	
MAY 2019 – DEC 2021	**Doctoral Research award (B2X)**	56,000 CAD

Fonds de Recherche du Québec - Nature et Technologies

JAN 2017 – DEC 2019 **McGill Engineering Doctoral Award (MEDA)** 96,000 CAD

McGill University

AUG 2013 – DEC 2015 **ADNOC Graduate fellowship** 90,000 USD

Abu Dhabi National Oil Company

Awarded 2nd place for final problem presentation and winner of best data visualization in the 11th Montreal Industreal Problem Solving Workshop	IVADO, UNIVERSITÉ DE MONTRÉAL, CANADA
Team leader of the first 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 voluntary commitment to the Graduate School's and the Graduate Student Affair's events	KHALIFA UNIVERSITY, ABU DHABI, UAE
Graduated Honors with distinction (2,000 AED)	KHALIFA UNIVERSITY, ABU DHABI, UAE
Made it to the Provost's list 3 times	KHALIFA UNIVERSITY, ABU DHABI, UAE

REVIEW SERVICE

Served as a reviewer on the following journals:

Journal	Number of papers
Scientific Reports	2
Sensors and Actuators A	2
IEEE Access	5
Journal of Global Optimization	1
Engineering Optimization	1
Artificial Intelligence for Engineering Design, Analysis and Manufacturing	2
AIAA Journal	1
IEEE Transactions on Industrial Informatics	1
Journal of Mechanical Design	1
The Aeronautical Journal	3

SKILLS

PROGRAMMING LANGUAGES

Python
C++
VB
R
MATLAB
HTML, CSS
Javascript

SPOKEN LANGUAGES

ENGLISH **Verbal**
Written
ARABIC **Verbal**
Written
FRENCH **Verbal**
Written
SWEDISH **Verbal**
Written

OPERATING SYSTEMS

SCIENTIFIC LIBRARIES Qt, PyTorch, TensorFlow, CUDA, Intel MPI, OpenCL

SOURCE CONTROL Git, Perforce

INTERACTIVE DEVELOPMENT ENVIRONMENTS VSCode, Xcode, Visual Studio, RStudio

TYPESETTING	LaTeX(and beamer), Microsoft Office
FINITE ELEMENT SOFTWARE	Ansys-APDL, Abaqus, NASTRAN
APPLICATION PROGRAMMING INTERFACES	Abaqus Fortran subroutines and python API, NX siemens API
CFD SOFTWARE	Ansys (CFX, Fluent, Workbench)
COMPUTER AIDED DESIGN	SOLIDWORKS, NX siemens
COMMUNICATION AND INTERPERSONAL SKILLS	Excellent written and verbal presentation skills Comfortable working in a target-driven and fast paced environment Data analysis, proposal writing and questionnaire design Attention to detail and ability to identify underlying trends and patterns

PERSONAL INTERESTS

- Gymnastics and calisthenics training
- Powerlifting
- Competitive gaming
- 3D printing hobbyist
- Car modding (muscle cars) and drag racing
- Tinkering and taking apart any machine and putting it back together!

REFERENCES

Prof. Michael Kokkolaras

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McGill Univeristy
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Prof. Ola Isaksson

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Chalmers Univeristy of Technology
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