

# Khalil Al Handawi, PhD

Montréal Québec, Canada  
khalil.alhandawi@mail.mcgill.ca  
khalhandawi.github.io  
github.com/khalhandawi  
linkedin.com/in/khalhandawi

## EDUCATION

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

## WORK EXPERIENCE

### Research

#### Department of Computer Science and Operations Research, Université de Montréal

MONTRÉAL, CANADA

MAY 2022 – PRESENT *Postdoctoral Researcher*

- Developed a research plan and won a Natural Sciences and Engineering Research Council of Canada (NSERC) fellowship to pursue said research at Université de Montréal.
- 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.

#### Systems Optimization Lab (SOL), McGill University

MONTRÉAL, CANADA

JAN 2021 – APR 2022 *Postdoctoral Researcher*

- Researched simulation-based decision-making for public health and policy-making during epidemics.
- Developed several [machine learning COVID-19 forecasting models](#) for inferring weekly pandemic trajectories.
- Applied state-of-the-art stochastic black-box optimization algorithms to tune machine learning hyperparameters and model selection.
- Develop GPU accelerated [epidemic models](#) for high simulation throughput to assist in policy-making during pandemics through the use of stochastic optimization.
- Invited to speak at the [INFORMS Healthcare conference 2023](#) in Toronto.

JAN 2017 – JAN 2021 *Research assistant*

- I was part of **Canadian/European industrial project** investigating additive repair technologies for aeroengine parts. I focused on optimization of aerospace design for AM remanufacturing.
- Developed mathematical tools and [software](#) for design space exploration and optimization achieving a **99.8% reduction** in effort to explore a 4-dimensional design space relative to full factorial design.
- Developed a thermomechanical simulation model for modeling additive manufacturing repair and life extension processes using transient coupled thermal/mechanical FEA simulations.
- Used machine learning models trained from expensive manufacturing simulations and a variant of kernel smoothing for estimating the sensitivity of design and process parameters to different requirements.
- My doctoral research paper was selected as a **best paper** by the ASME Journal of Mechanical Design in 2021.
- Received a Fonds de Recherche du Québec (FRQNT) doctoral award.

- Co-developed a novel lifecycle cost model based on system dynamics to model the effect of life extension on lifecycle costs.

## Systems Engineering Design (SED) Lab, Chalmers University of Technology

GÖTEBORG, SWEDEN

SEP 2021 – DEC 2021 *Postdoctoral Researcher*

- Integrate my doctoral research (design under uncertainty) into SED lab activities.
- Research change propagation and absorption in engineering design (applied to aeroengine systems).
- Authored a [Python library](#) for margin and change propagation management in engineering systems.
- Used said library in design space exploration to concurrently develop and analyze **6,552 conceptual designs** of an aeroengine component and [visualize the results](#) using interactive tools.

## Asset Integrity Management Systems (AIMS) Lab, Khalifa University

ABU DHABI, UAE

AUG 2013 – JAN 2017 *Research Assistant*

- Developed fiber optic structural monitoring sensors for mitigating upto **\$1M of corrosion costs**.
- Developed and simulated a [fiber optic-based corrosion sensor](#) with an accuracy of  $\pm 2\text{mm/s}$ .
- Developed a new accelerated corrosion testing setup to simulate **2 years of corrosion in 2 hours**.

---

## Industry

### International Air Transport Association (IATA)

MONTRÉAL, CANADA

MAY 2022 – PRESENT *Visiting researcher*

- Analyze IATA data involving **25M flight schedules** using graph representation learning.
- Develop community detection algorithms for graphs with over **10K nodes** and **100K edges**.
- Organize flight schedule data into a mySQL database for archival, and retrieval of data.

### GKN Aerospace Engine Systems

TROLHÄTTAN, SWEDEN

JUNE 2017 – JAN 2020 *Visiting researcher*

- Participated in a [technology transfer](#) at GKN Aerospace to translate my doctoral research into industrial practice by provided training modules and workshops to GKN engineers on the software tools that I have developed.
- 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 AN-SYS) to evaluate hundreds of concepts for a turbine rear frame component.

### Yokogawa

ABU DHABI, UAE

AUG 2012 – MAY 2012 *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

### McGill University

MONTRÉAL, CANADA

JAN 2017 – DEC 2020 *Systems Optimization Lab*

- Update the lab's website and disseminate new research to the public.
- <http://www.sol.research.mcgill.ca/>.

### Khalifa University

ABU DHABI, UAE

JAN 2014 – AUG 2015 *Solar car project: Maintenance and procurement manager*

- Designed an engineering workshop for building and maintaining electric solar vehicles.

JUN 2011 – MAY 2013 *Baja SAE team leader*

- 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

#### McGill University

MONTREAL, CANADA

SEP 2022 – DEC 2022

*Adjunct lecturer, MECH559: Engineering Systems Optimization*

- Developed [Python notebooks](#) as teaching aids for the students to understand the implementation of common optimization algorithms and their application to engineering systems.
- Received participation rate of **69%** in course evaluations with an average score of **4.2/5.0**.
- Hosted **several guest** lectures with aerospace industry professionals to demo optimization applications.

SEP 2018 – DEC 2019

*Teaching assistant, MECH362: Mechanical Lab*

- Was a teaching assistant for MECH362 for 3 semesters.
- Supervised lab sessions covering the following theoretical courses: MECH240 Thermodynamics, MECH315/419 Mechanics, MECH331 Fluid Mechanics, MECH346 Heat Transfer.
- Prepared lab manuals, conducted labs, graded student reports, and provided feedback.
- Reported areas of the curriculum that students were constantly struggling with to the department.

JAN 2018 – MAY 2018

*Teaching assistant, FACC400: Engineering Professional Practice*

- Was a teaching assistant for FACC400 for 1 semester.
- Conducted town halls on relevant and pressing sociopolitical topics facing modern day engineers.
- Substituted lecturers, and provided feedback to students on the townhalls.

#### Khalifa University

ABU DHABI, UAE

JAN 2014 – MAY 2014

*Teaching assistant, System Dynamics and Controls*

- Conducted lab sessions on transient systems and multiple degree of freedom systems.
- Prepared homework solutions and tutorials for the students on theoretical topics.
- Graded students' midterms examinations.

SEP 2013 – DEC 2013

*Teaching assistant, Computer Aided Design*

- Conducted computer lab sessions to educate the students on the use of modern CAD software (SolidWorks).

SEP 2012 – MAY 2013

*Grader, Physics II*

- Graded homework, midterms, and final examinations for the undergraduate physics course.

---

### Supervision

JAN 2016 – JAN 2017

**Asset Integrity Management Systems Lab (AIMS), 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

**Capstone 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 ● Open-source code ● Web application ● DOI: [10.1115/1.4047908](https://doi.org/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](https://doi.org/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 a 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](https://doi.org/10.1109/TETCI.2021.3107496)

## PUBLICATIONS

---

### Submitted articles

---

**K. Al Handawi**, A. Brahma, D. Wynn, M. Kokkolaras and O. Isaksson (2023). Design space exploration and evaluation using margin-based trade-offs. *Journal of Mechanical Design*  
*funded partially by NSERC and Area of Advance of Chalmers University*

## 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](https://doi.org/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](https://doi.org/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](https://doi.org/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*, 1: pp 203 – 230. <https://doi.org/10.55417/fr.2021008>  
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](https://doi.org/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](https://doi.org/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](https://doi.org/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](https://doi.org/10.1016/j.snb.2016.05.167)  
funded by Abu Dhabi National Oil Company

## Refereed Conference Papers

---

L. Lawand, T. Hajali, **K. Al Handawi** and A. Brahma (2023). Industrialisation of additive manufacturing: Assessing the impact of excess margins on manufacturing costs. in *Proceedings of the 9th International Conference on Research Into Design*, Bengaluru, India, ICORd'23.

**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**, 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](https://doi.org/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](https://doi.org/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	<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
<hr/>		
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 Industrial 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 Affairs 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
Designs	1
Scientific Reports	2
Sensors and Actuators A	2
IEEE Access	6
Journal of Global Optimization	1
Engineering Optimization	1
Artificial Intelligence for Engineering Design, Analysis and Manufacturing	2
AIAA Journal	2
IEEE Transactions on Industrial Informatics	1
Journal of Mechanical Design	1
The Aeronautical Journal	3

## SKILLS

### PROGRAMMING LANGUAGES

<b>Python</b>	●●●●●●●●○○○○
<b>C++</b>	●●●●○○○○○○○○
<b>VB</b>	●●●○○○○○○○○○○
<b>R</b>	●●●●●○○○○○○○○
<b>MATLAB</b>	●●●●●●●○○○○○
<b>HTML, CSS</b>	●●●○○○○○○○○○○
<b>Javascript</b>	●●○○○○○○○○○○○○
<b>mySQL</b>	●●●●●○○○○○○○○

### SPOKEN LANGUAGES


ENGLISH	<b>Verbal</b>	●●●●●●●●●●○○
	<b>Written</b>	●●●●●●●●●○○○
ARABIC	<b>Verbal</b>	●●●●●●●●●○○○
	<b>Written</b>	●●●●●●●●●○○○
FRENCH	<b>Verbal</b>	●○○○○○○○○○○○○
	<b>Written</b>	●●●●○○○○○○○○
SWEDISH	<b>Verbal</b>	○○○○○○○○○○○○○
	<b>Written</b>	●●○○○○○○○○○○○

OPERATING SYSTEMS   


SCIENTIFIC LIBRARIES  Qt, PyTorch, CUDA, Intel MPI, OpenCL, Pandas, scikit-learn

SOURCE CONTROL  Git, Perforce

INTERACTIVE DEVELOPMENT ENVIRONMENTS  VSCode, Xcode, Visual Studio, RStudio


TYPESETTING  L<sup>A</sup>T<sub>E</sub>X(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) - basic usage

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  
Very methodical and organized. Pays attention to detail and is able to identify underlying trends and patterns

## PERSONAL INTERESTS

---

- Gymnastics and Powerlifting training
- Automotive enthusiast
- Competitive gaming
- 3D printing hobbyist
- Tinkering and restoration of old machines
- Tabletop games (Warhammer and D&D)

## REFERENCES

---

### **Prof. Michael Kokkolaras**

POSITION Associate Professor  
EMPLOYER [Department of Mechanical Engineering](#)  
[McGill Univeristy](#)  
EMAIL [michael.kokkolaras@mcgill.ca](mailto:michael.kokkolaras@mcgill.ca)

### **Prof. Fabian Bastin**

POSITION Professor  
DEPARTMENT [Department of Computer Science](#)  
[Université de Montréal](#)  
EMAIL [fabian.bastin@umontreal.ca](mailto:fabian.bastin@umontreal.ca)

### **Prof. Ola Isaksson**

POSITION Professor  
EMPLOYER [Department of Industrial and Materials Science](#)  
[Chalmers Univeristy of Technology](#)  
EMAIL [ola.isaksson@chalmers.se](mailto:ola.isaksson@chalmers.se)

### **Dr. Ibrahim Chamseddine**

POSITION Instructor in Investigation  
DEPARTMENT [Department of radiation oncology](#)  
[Harvard Medical School](#)  
EMAIL [ichamseddine@mgh.harvard.edu](mailto:ichamseddine@mgh.harvard.edu)