

MECHATRONICS

Opportunities in Lebanon

ABSTRACT

Mechatronics is an integrated combination of mechanics and electronics. To engage Lebanon in the robotics revolution, there should be a plan to encourage innovation. Since change begins from within, every ministry, company, university or any establishment should start implementing an innovation policy through their endeavor.

Eng. Hania Zaatari

Industrial Permit and Control Department - South
Ministry of Industry

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List of Abbreviations

ALI	Association of Lebanese Industrialists
AUB	American University of Beirut
BAU	Beirut Arab University
CiT	Center of Innovation and Technology
CNRS	National Center for Scientific Research
GDP	Gross Domestic Product
GII	Global innovation index
IoT	Internet of Things
IRI	Industrial Research Institute
LAU	Lebanese American University
LIRA	Lebanese Industrial Research Achievements
MEMS	Manufacturing, robotics, Micro-Electromechanical Systems
MoEH	Ministry of Education and Higher Education
E	
MoI	Ministry of Industry
NI	National Instruments
NTTO	National Technology Transfer Office
OEA	Order of Engineers and Architects
R&D	Research and Development
RPI	Rensselaer Polytechnic Institute
SME	Small and medium enterprises
TTU	Technology Transfer Unit
UL	Lebanese University

Introduction

Today, with the invasion of electronics and the Internet of Things (IoT), engineers are using mechatronics in various fields. Biomedical products are examples of the useful application of mechatronics to preserve human health. The range of applications is increasing day by day with more inventions, with nanotechnology serving as an essential complimentary field for new developments in medical and defense areas among others. Eng. Tetsuro Mori first used the term “mechatronics”, forty years ago to, describe an electronic control system he developed in a mechanical factory owned by Yaskawa Electric Corp. (Brown, 2011).

Definition of Mechatronics

The Dictionary of Mechanical Engineering defines mechatronics as the integration of mechanical, electrical, electronics and software engineering (Atkins & Escudier, 2013).

Davim (2013) defines mechatronics as “the portmanteau of Mechanics and Electronics”, describing it as an interdisciplinary mix of mechanical, electronics and computer engineering in integrated design. Today, mechatronics has evolved into a modern engineering field that requires knowledge and experience in more than one area. Mechatronics allowed the emergence of the Robotics field. Then, Robotics itself invaded the automotive industry, motion and intelligent control, modeling and design, actuators and sensors, manufacturing, vibration and noise control, and optoelectronics and micro-devices; including nanotechnology (Obaia, 2016).

Dr. Kevin Craig, from The Rensselaer Polytechnic Institute (RPI) developed an interesting Euler diagram (Figure 1) showing the integration of different engineering aspects and

the diversification of the application fields in automotive, aerospace, medical, xerography, defense systems, consumer products, manufacturing, and materials processing (Craig, n.d.).

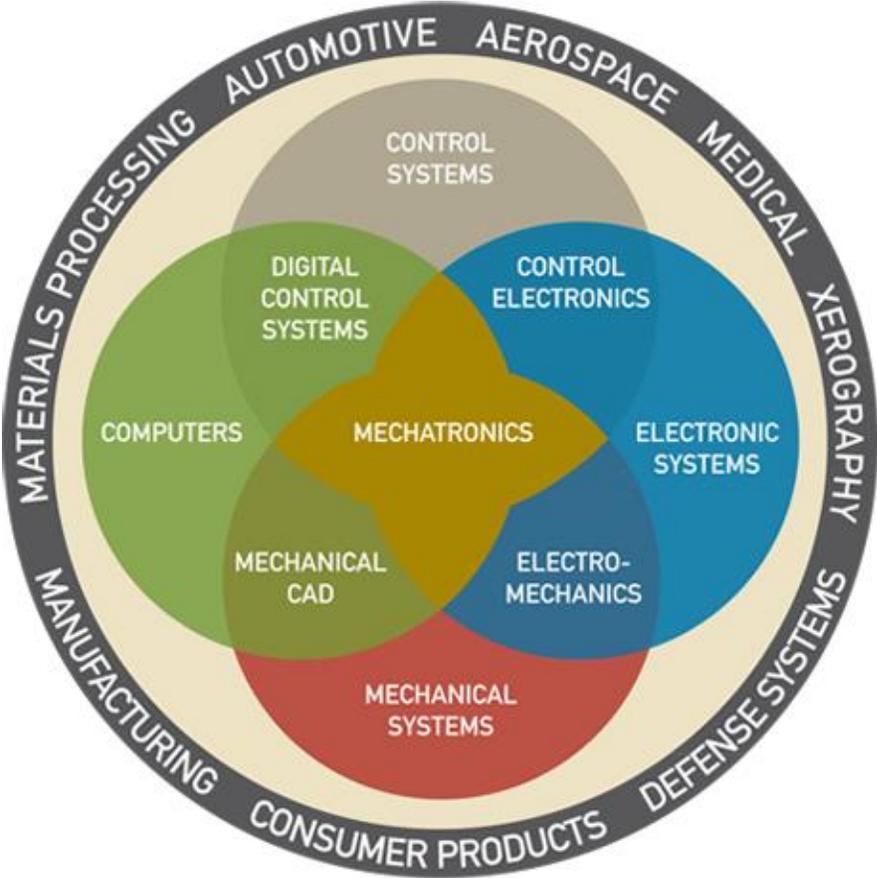


Figure 1 The Euler diagram of Mechatronics by Kevin Craig (Craig, n.d.).

Dr. Kraig also produced the following representation of the various physical and engineering aspects of mechatronics: mechanical, electrical, pneumatic, hydraulic, chemical, thermal, optical, acoustical and software (Craig, n.d.).

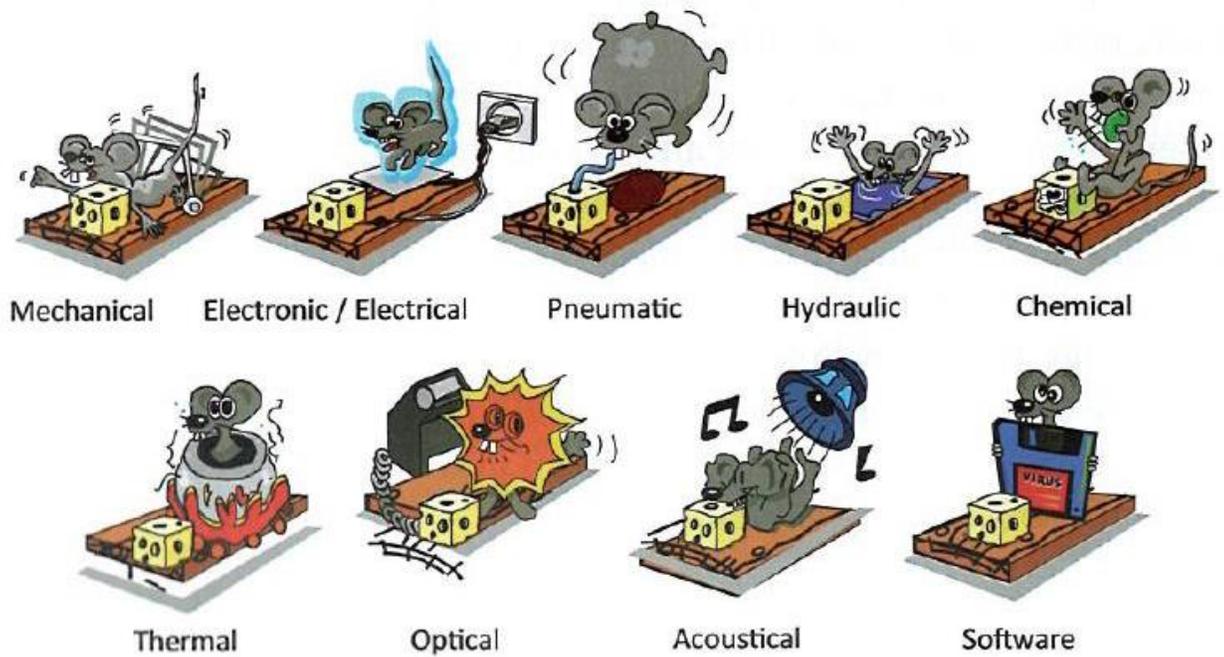


Figure 2 The various physical/engineering fields connected to mechatronics (Craig, n.d.).

Since mechatronics requires knowledge of different fields and is used in vast arenas, it has become a subfield in Engineering. It has also been introduced as a specialization in universities worldwide and more recently in Lebanon.

Mechatronics in Lebanese Academia

The Mechatronics Engineering field became a separate specialization, after being a sub-major in mechanical engineering for many years before. It is now offered at different universities in Lebanon starting with the Balamand University, Lebanese University (UL), Lebanese American University (LAU), Matn University College of Technology (MUC), among others. The American University of Beirut (AUB), and the Beirut Arab University (BAU), on the other hand, still teach mechatronics as a track offered within the mechanical engineering program.

Students graduating with a mechatronics degree can work in different fields including oil drilling, automation, manufacturing, robotics, Micro-Electromechanical Systems (MEMS), biomedical systems among others. Between 2012-2017, a total of 81 mechanical engineers graduated with a mechatronics degree in Lebanon, and registered in the order of Engineers and Architects (OEA).

Impact on Business and Economics

Mechatronics is a multi-faceted degree that facilitates the development of various other fields. With the increased use of technology, and fast changes in the market, there is a significant need for mechatronics today. Mechatronics is particularly important to enhance competitiveness in companies through innovation, communication, collaboration and integration (Craig, n.d.).

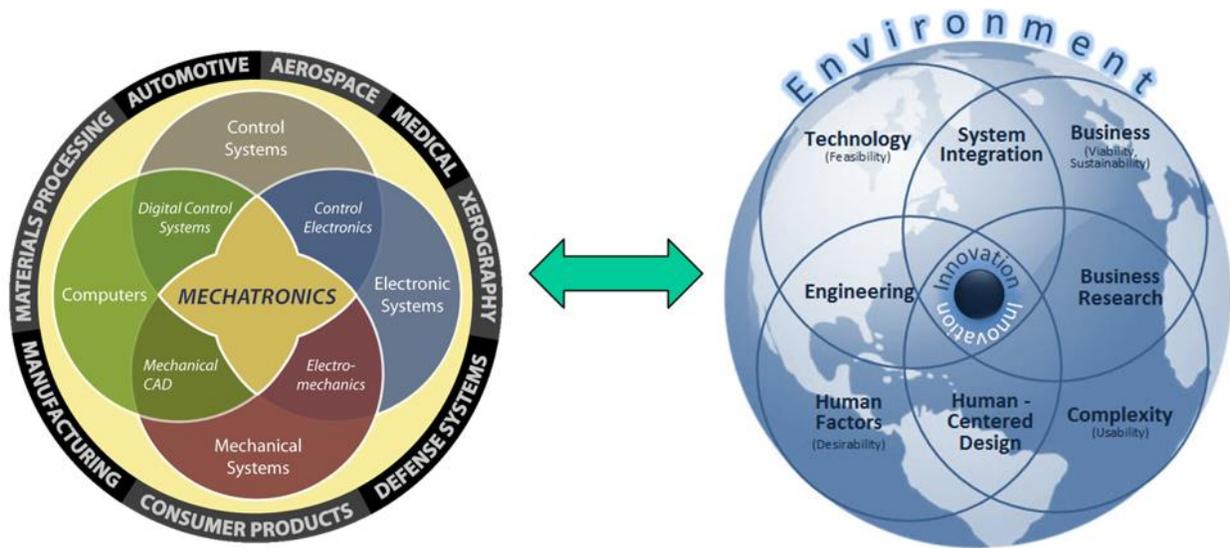


Figure 3 The link between mechatronics and innovation (Craig, n.d.)

Innovation is “the process of translating an idea or invention into a good or service that creates value for which customers will pay” (WebFinance Inc., n.d.). Therefore, the link between

mechatronics and innovation is significant in creating entrepreneurship and developing economies. Most countries today encourage innovation and entrepreneurship and seek to expand small and medium enterprises (SME's) in light of their contribution to the Gross Domestic Product (GDP), minimizing unemployment and turning the economic wheel (Shukla, 2017).

Another indication of how vital innovation and entrepreneurship have become in the world today is the number of grants and initiatives offered to innovators all around the world. The reason for all the emphasis is not only the economic return from innovation but also the image of a company and a country. Innovation is being measured and ranked by a vital index called the global innovation index (GII). The GII helps policymakers in creating and developing the environment for innovative companies, and therefore promoting long-term growth, enhanced productivity and job creations (The Global Innovation Index, 2017).

Applications and examples

With the growing importance and usage of smart products and the IoT, the market allows for a vast arena for innovation. National Instruments (NI) Arabia is a subsidiary of National Instruments Corporation. NI Arabia is working in the Arab world to provide the suitable systems that will help to accelerate innovation, productivity, and discovery. The NI Alliance Partners show only six companies registered in Lebanon, working in automation, control, and vision. Their industries are related to the automotive industry, education, machines and mechatronics (National Instruments, n.d.). The listed Lebanese NI Alliance partners are Nairi-Tech, E2, Green Power Generation, Ideation Systems, mekatronico and yle. Most of those companies are sister companies to international companies. Some examples of Lebanese entrepreneurs making use of Mechatronics include The Little Engineer in education, Dom controls in home automation, Kashida in 3D typography, LittleBits and Cherpa.

Opportunities in Lebanon

Lebanon has a country risk rating of C in the risk assessment, which means the business environment is challenging. This is due to the unstable political and economic situation (globalEDGE, 2017). Expenditure on Research and Development (R&D) is low, the general infrastructure is not developed enough, and imports are high especially in high-tech products (The Global Innovation Index, 2017). Many Lebanese entrepreneurs, therefore, prefer to take their ideas abroad and to succeed in the different countries of the world. Incentivizing Lebanese entrepreneurs to stay in Lebanon requires a governmental policy that recognize innovation starting at the university level. Such a policy needs to encourage and support those innovators into creating their entrepreneurship companies.

The SWOT analysis of the business environment in Lebanon can probably help in making policy decisions. The emerging gas discovery (globalEDGE, 2017) and exploration of the potential discovery of oil and gas in Lebanon (lebanongasandoil, 2018) presents a significant opportunity for oil and gas companies. Such developments can also serve complementary innovative companies working on new solutions and products that can help tracking and smart exploration and exploitation of oil and gas.

Other opportunities lie in education, as Lebanon is known to have a very robust educational system. But again, there is no real limitation for the applications. The trick for entrepreneurs to succeeding in Lebanon and to reducing the risk is to have an external market, and not depend on the local market. The grand challenges for engineers can be an excellent inspiration for entrepreneurs to set up their own companies and start working in Lebanon.

According to the National Academy of Engineering, the fourteen grand challenges for engineers, in the 21st century, are to (National Academy of Engineering, n.d.):

- 1- Make solar energy affordable.
- 2- Provide energy from fusion.
- 3- Develop carbon sequestration methods.
- 4- Manage the nitrogen cycle.
- 5- Provide access to clean water.
- 6- Restore and improve urban infrastructure.
- 7- Advance health informatics.
- 8- Engineer better medicines.
- 9- Reverse-engineer the brain.
- 10- Prevent nuclear terror.
- 11- Secure Cyberspace.
- 12- Enhance virtual reality.
- 13- Advance personalized learning.
- 14- Engineer the tools for scientific discovery.

Focusing on the challenges, and opportunities in Lebanon, an entrepreneurial company should also work on cost-effective initiatives. Decreasing the number of employees cuts down expenditure, and whereas targeting external markets, in addition to the local market, lowers the risk. Startups will need to draw on knowledge, skills, expertise, marketing, and startup ecosystems. The Ministry of Industry (MoI) is already playing a role, and helping innovation in mechatronics to prosper through their activities and programs. Some of the programs and activities that the MOI carried out in this regards are:

- 1- Launching the new innovation concept (2035) “Created in Lebanon”, as well as incorporated innovation in its vision, published as Integrated Vision For The Lebanese industrial Sector 2025 (MoI, 2015).
- 2- Working closely with the Industrial Research Institute (IRI) and incorporating innovation in its strategy.
- 3- Sponsoring and participation in the NI-Day events.
- 4- Following up on the Lebanese Industrial Research Achievements (LIRA) program
- 5- Conducting studies and research, accompanied by workshops and conferences.
- 6- Signed an agreement with the Ministry of Education and higher Education (MoEHE) and the Association of Lebanese Industrialists (ALI) to design educational programs as per the industrial needs.
- 7- MoI conducted several entrepreneurial workshops in universities to encourage the graduated students (BS, MS, PhD) to be productive entrepreneurs.

With the ongoing effort of the MoI, new and old factories should also incorporate innovation through their working teams, and through developing their machinery. This will allow new workshops with new technologies to emerge.

Suggested Solutions

In October 2017, the National Center of Scientific Research (CNRS) held a training session in their premises. During the training session, CNRS declared that it had established an inhouse National Technology Transfer Office (NTTO). Attendees were from different universities and ministries. Universities were advised to establish innovation centers to encourage discovery of entrepreneurs and boost innovation amongst students. Some of the universities and research institutes already established their innovation centers. AUB established the Center for Research

and Innovation (CRInn) which is under the Technology Transfer Unit (TTU) and the Office of Grants and Contracts (OCG) (AUB, n.d.). The IRI as well, established the Center of Innovation and Technology (CiT) in 2012.

With the structure having many centers in Lebanon, there was an initiative from NI to establish a small and diversified team, including professors, startup ecosystem providers, technology providers, investing bodies, technology programs and the Ministry of Industry. The role of such a team is to help fill the skills and market gaps facilitating access to technology. The suggested inter-institutional team can help find the proper market for raw materials, semi-finished products, sub-contracting, and for the final product itself. It can support young innovators and boost their innovation to creation.

In fact, every institution should have a small innovation team composed of different employees from each department. **Because change begins from within, it is vital for the MOI to take up this initiative and put in place its first innovation team whose members may change on a yearly basis.**

Conclusion

Lebanon's GII rank is the 81st in the world, and 14th among 19 countries in the Northern Africa and Western Asia (See Annex). As mechatronics as a field is invading our world with IoT and smart products, it is imperative for Lebanon to accelerate national efforts to encourage innovation in technology, SME's developments and entrepreneurship. Public policies should be geared towards helping entrepreneurs develop new products facilitating access to external markets. Policies and projects are a good start. The ministry should highlight the achievements of its in place dynamic innovation team, to be a good example for other ministries. The NI initiative

is also a good idea for creating a cross-innovation working team that could spearhead technological breakthrough in mechatronics and technology.

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Annex

Country/Economy	Score(0–100)	Rank	Income	Rank	Region	Rank	Efficiency Ratio	Rank
Israel	53.88	17	HI	17	NAWA	1	0.77	23
Cyprus	46.84	30	HI	29	NAWA	2	0.74	28
United Arab Emirates	43.24	35	HI	34	NAWA	3	0.49	104
Turkey	38.90	43	UM	5	NAWA	4	0.84	9
Qatar	37.90	49	HI	41	NAWA	5	0.61	68
Saudi Arabia	36.17	55	HI	42	NAWA	6	0.53	96
Kuwait	36.10	56	HI	43	NAWA	7	0.79	18
Armenia	35.65	59	LM	5	NAWA	8	0.80	17
Bahrain	34.67	66	HI	44	NAWA	9	0.56	88
Georgia	34.39	68	UM	17	NAWA	10	0.63	60
Morocco	32.72	72	LM	7	NAWA	11	0.61	71
Tunisia	32.30	74	LM	9	NAWA	12	0.62	65
Oman	31.83	77	HI	47	NAWA	13	0.46	115
Lebanon	30.64	81	UM	24	NAWA	14	0.61	69
Azerbaijan	30.58	82	UM	25	NAWA	15	0.50	103
Jordan	30.52	83	UM	26	NAWA	16	0.65	57
Egypt	26.00	105	LM	19	NAWA	17	0.59	81
Algeria	24.34	108	UM	35	NAWA	18	0.47	111
Yemen	15.64	127	LM	27	NAWA	19	0.40	119

Table 1 An excerpt from GII 2017 report (Cornell University, INSEAD, WIPO, 2017)