

OPERATIONS RESEARCH AND COOPERATION INTEGRATING TOOL: THE CASE OF ALGERIA

Prof. Dr. Abdelkader Khelladi

Member of Algerian Academy of Sciences and Technologies (AAST)

Abstract

Since the end of WWII, Operations Research (OR) has gained an important role for the whole world and especially the Mediterranean one. Algeria entered this activity just after its independence in 1962, characterized by a lack of specialists in technologies and sciences. A huge scientific and technological training program started few years later, followed by the introduction of OR at the end of the seventies sustained by international cooperation.

Since then, an organized and continuous cooperation program was maintained. Quickly OR was used to solve some real problems facing the country. This shows how OR techniques may be an integrating tool for enhancing scientific and technological cooperation.

In this chapter, some examples of works and applications developed in Algeria will be presented as illustrations. We also try to sketch the ways and with the help of whom Algeria mastered OR techniques and what are the main challenges still away to solve to extend this cooperation to the Mediterranean countries.

1. Introduction

Looking and analyzing past successful shared experiences may give insights and hope to start new multilateral cooperation. The Mediterranean Sea is so warm full to our hearts that it deserves to be commonly cheered around by countries involved in its protection and its development, so this introducing study.

Let me try first to precise the meaning of the terms of the title.

1.1. The Meanings: Operation Research (OR) is meant as its usual and well known meaning as the set of all the mathematical and rational techniques to approach the solution of any real problem of management and/or decision which faces a society, a company or any other organization. The word cooperation is designated,

for at least two persons, as all the ways to work in collaboration about a situation to make advances together. The integrating tool is just a shortcut for the general principles to have a common useful activity along a multidisciplinary problem. The word Algeria is the actual country but its situation before the independence in 1962 may also be evoked.

Just recall for the sake of history, the definition of OR given by the US Department of Defense as: “*The analytical study of military problems undertaken to provide responsible commanders and staff agencies with a scientific basis for decision on action to improve military operations.*”¹

1.2. Short Historical Recalls: Indeed, Operations Research had a lightning development during and after WWII. The USA and the UK with USSR felt the need of that mathematical and scientific technology for managing the complex war operations. Quickly after the war, the civilian companies grasped the ideas and started to use those scientific acquisitions as Management Science, just after their disclosure from military secrets, for a wide range of real problems.

The adventure of OR spread away in other countries from the Mediterranean Sea like Turkey and other occidental countries. By that time, countries like Algeria were still under the colonial occupation.

1.3. The Case of Algeria: Since the very beginning of colonial rule, the scientific and technological developments have been consciously slowed down if not forbidden for the Algerians. The colonized people were not involved then in OR development. During the celebration of the first century of the colonization in 1930, the foreign settlers were even saying, among many other racist words, that all is done for the colonization and even Islam will disappear from Algeria.

On the other hand, just say quickly that during the Liberation War (1954-1962) the nationalists had to be intuitively clever to circumvent the physical barriers put in place by the colonial army to block some escape streets. The nationalists had to intuitively find a kind of shortest path; even if they were not accustomed to that type of OR thinking.

As a matter of fact, the situation of our country was very bad in the aftermath of the independence in 1962. The severe lack of scientists and technologists was critical. However, the National Liberation War has showed the very need for the acquisition of military sciences and technologies to build on a modern National Liberation Army and a development of the country and the people. The National Liberation Army, with the support of friendly countries, started to master the necessary military sciences and technologies between 1954 and 1962.

So, quickly after 1962, the government scheduled an enormous program of training in sciences and technologies. The *Ecole Polytechnique d'Alger* designed before for

¹ S. H. Shrader, *History of OR in US Army*, 3 Vol., Washington: US Government Printing Office, 2006.

the children of the French settlers during decades, pursued its work after the independence with a scientific support of UNESCO in particular, represented by Pr. Shoulkine and headed by Pr. Ouabdeslam, a statistician. Algeria benefited also from a special JFK's help for training about a hundred students in the USA universities in sciences and technologies, but they did not all come back to their native country after being graduated.

However, the needs were so huge that, for mathematics in particular, the orientation was mainly towards the Pure Mathematics, during about fifteen years. The Applied Maths like OR was not under consideration. The country has to start at the very beginnings and acquired, slowly, the teachers in sciences and technologies first. All these programs were supported by a worldwide cooperation: France, UK, USSR, Poland, Hungary, etc. The unique meeting with a kind of new type of mathematics was a thesis, in Algiers University, on Social Choice in the first few years of the seventies by Pr. Hadjiat, under the supervision of a professor from Paris; but it was not followed by any bigger and sustainable development program.

2. Cooperation to Introduce OR in Algeria

2.1. The Origins: The very first few ideas were born in the middle of the sixties at the *Ecole Polytechnique d'Alger* where the needs for Industrial Engineering appeared since the first few years. Unfortunately, neither real and effective plan nor strong wills were settled in this period.

It was the very need of the national petroleum company SONATRACH (SH) which opened the doors for the introduction of OR. In 1976 SH decided to complete its organization by putting an Operational Division for which OR was a founding necessity. Two mathematics teachers from the University of Sciences and Technology Houari Boumediene (USTHB) in Algiers, Benayat and Khelladi, were accepted and sent to ORC at MIT (headed by Jeremy Shapiro) during the year 1976/1977. This start triggered the whole process for introducing OR in Algeria. After that, the Institute of Mathematics of the USTHB, headed by Pr. Djedour, started to be very interested in this new (for Algeria) mix of Mathematical Techniques and Computer Sciences, dedicated to solve real life problems. As a matter of fact, the Pure Mathematics training was a good starting point to master the necessary mathematical content of OR.

Therefore, since in Algeria the OR is taught as a Mathematics specialty, it is amusing to confront Algeria's experience with the remark of Barkley J. Rosser, even if there were some sceptics: *"Is OR (Operations Research) mathematics? Nowadays, the practitioners insist that it is a separate discipline, and I guess by now [1982] it is. It is certainly not now taught in departments of mathematics. But, it grew out of mathematics. At the beginning of OR, during the war, it was mathematics according to my definition above, although some of the very good operators were physicists and*

chemists. *The Air Force Generals and Navy Admirals thought it was wonderful stuff. You could not have convinced one of them that it was not mathematics*².

2.2 The Birth of Cooperation in OR: Cooperation with well-known universities was felt as an unavoidable passage because the Algerian universities were not ready to start OR alone.

The first talk on OR was done at USTHB in the spring of 1977 by Pr. Brans from Belgium on Time Series. This conference was accompanied by conferences on Statistics, Queues Theory by Pr. Dreesbecke and Hallin and the very beginnings of MCDM by Pr. Vinckle from ULB, Brussels.

In 1978 the USTHB signed a general agreement on Scientific and Technological cooperation with the French university at Grenoble, UJF. The IMAG laboratory of UJF was quickly involved in OR training in Algeria.

The following researchers and teachers, among others from IMAG, went to USTHB during many blocked weeks to give lectures for students and involved interested Algerian teachers, under the financial and organizational official bilateral cooperation between Algeria and France.

a. Pr. Claude Bezaken (passed away in 2017) and Pr. Nguyen Huy Xuong (passed away in 2006?) for an introductory course on Combinatorial Optimization and Structures.

b. Pr. Charles Payan, Pr. François Jaeger (passed away in 1997) and Pr. Jean-Marie Laborde for a course on Graph Theory and Network Optimization.

c. Pr. François Brodeau (passed away in 1994), Pr. Bernard Van Cutsem for a course on Statistics and Stochastic Processes.

The cooperation with Grenoble was almost dedicated and oriented only to classical analysis of one objective function even if Pr. from IMAG was working on Social Choice, but with not so much success in Algeria.

The venue of Pr. Konrad Engel (Rostock, Germany) for about five years was a strong boost on Combinatorics, Poset Theory and more.

The personal involvement of all these colleagues and others in this cooperation was a very successful helping hand to introduce formally OR in Algeria. It is at the very origin and birth of the Department of Operation Research, by the end of the seventies. Nowadays it is the more important one at the Faculty of Mathematics of the USTHB.

2.3. Meeting MCDM/MCDA and AHP/ANP: The MCDM/MCDA techniques and theories started with Pr. Vinckle who accepted the supervision of an OR graduate student for a doctorate thesis at the beginning of the nineties. This student, now Pr. Abbas, achieved his PhD in 1994 and went back to introduce that in the official OR curricula.

² J. B. Rosser, "Mathematics and Mathematicians in World War II", *Notices of the American Mathematical Society* 29, (1982), pp. 509-515.

In 1995 I found, at the library of IMAG, Grenoble, a book on AHP of Thomas Saaty (passed away in 2017). I sent him a letter asking for support and help to introduce AHP in our trainings. He was ill and in hospital and the answer was given by Pr. Vargas, welcoming the idea. Soon after, our demand has a successful answer; Mrs. Rozann Saaty sent back free of any charges all the books on AHP and ANP written by Thom with their commercial software on AHP, *EcPro*. The full commercial software was also free of any charge for the Algerian University and students and teachers, at the unique condition to not use it for commercial purposes. Since then AHP/ANP are taught in the OR Department and other universities acquired to OR, like UMMTO (Tizi Ouzou) UMAB (Béjaia) and USDB (Blida). The students are using widely these techniques for solving real life problems. Some are involving AHP/ANP in their research subjects. The contact with the Thom's group was maintained only by mail, until this year where Thom has passed away and for which we sent a mail in posthumous recognition for the big boost we received from him.

By the mid of the first decade of the 21st century, Cryptography by Pr. Bouroubi, Risk Analysis by Pr. Maamra and Financial Mathematics by Pr. Boukhatala, were added to complete the topics of the OR Department, of course with foreign help.

All these experiences are also another kind of realistic and fructuous cooperation. They show also what kind of work can be done together, if there exists a real will to share and help and exchange, even if we are very far from each other.

2.4 The Weekly Seminar of OR Department: Since the early eighties the new OR teachers and researchers felt the necessity to meet and share and exchange their new OR activities. A formal Weekly Seminar of OR Department was settled in 1981/1982 with the support of colleagues from Grenoble to attain the goals. It started by the exposition of what someone had read and followed by an open discussion. The main sources for Algerians were old available RAIRO and Management Sciences journals, while colleagues from Grenoble completed the local initiatives by newer presentations, mainly on research subjects. For instance, Pr. Jaeger takes about 10 days in 1981 for a detailed exposition of the seminal paper of Will Tutte, *Lectures on Matroids*³.

This seminar reinforced the relationships between the members of the Department and, slowly but surely, became a genuine meeting where the research works were showing a thriving activity. The presentations focused on almost all aspects of OR, from the approach of real problems to the developments of mathematics of OR: Graphs and Networks, Optimization, Time Series, Decision problems, etc. This OR meeting is still working nowadays and continuously evolving according to the most recent research activities of 68 faculty members from which 17 full professors in OR fields. This weekly meeting has become a vital part for all researchers of the Department and even welcomes foreign personalities.

The Weekly Seminar evolved and the first OR Franco-Algerian Meeting was organized at Algiers in 1983 and the last one in 1992. It was the start of many other na-

³ W. T. Tutte, "Lectures on matroids", *Journal of Research of the National Bureau of Standards Section B*, 69, (1965), pp. 1-47.

tional and international OR conferences in Algeria, under various auspices and specialties. OR is a very part of the Algerian Mathematical Society since the beginning. To conclude this section, it should be noted that, of course, there were some opposition for the introduction of OR in the Mathematics Institute at the beginning. However, this negative attitude does not deserve any other word than the silence, looking at the success of this scientific adventure.

3. Curricula, Students, Careers and Examples

3.1. Curricula: The help of lecture notes of Sakarovitch, Xuong and Van Cutsem and Brodeau, were a very nice beginning because Algeria started with exactly the same texts as those used at Grenoble. There were Sakarovitch's *Théorie des Graphes*, *Optimisation dans les Réseaux*, *Optimisation Combinatoire*, which became the very tools to learn OR.

The lecture notes by Xuong on *Introduction to Combinatorics* helped students and researchers to be accustomed to that new knowledge in Algeria.

The van Cutsem's *Classification* and the Brodeau's *Statistics and Stochastic Process* were valuable references for the beginners.

Jean Fonlupt and Michel Uhry programming-oriented courses were the stepping stone for the use of Computer Science in OR in Algiers.

The research papers and wide discussions also helped the starting research in OR Technology. Many research-level talks were organized by every visitor from Grenoble.

Jean-Marie Laborde, a specialist on Graph Theory, and Claude Benzaken, a specialist on Combinatorics and Hypergraphs, were the real administrative animators of this cooperation program during more than a decade.

This cooperation program even allowed buying books under the bilateral cooperation financial support (Urban Operation Research and Roy's books as examples among many others). The first portable Apple computer was also bought in that way in the late eighties.

The first type of degree was called DES (Diploma of Higher Studies). It was a four years training program, starting with three semesters of Calculus and other Mathematics courses, which were followed by five semesters on specific courses OR dedicated.

After about five years, it seemed evident that an engineering degree will be a better answer to the need of the National Economy. This was a five year training program, starting with two years Calculus and other Maths curricula, followed by three years dedicated to OR courses. The tenth semester is devoted to a Memoir. The memoirs

were the brand new meeting with the real life problems facing Algerian Companies and Administrations. They boosted the development of this new field because OR capabilities became visible to the society. OR began to be a real challenge to Computer Science, until the latter gained its independence from the Mathematics Institute in 1987.

3.2. Students: The novelty OR training attracted, since the very beginning, many mathematics students. As a matter of fact, they saw throughout it real applications using Computer Science Techniques. They did not feel that approach and this philosophy in their classical Pure Mathematics curricula. The first OR student's promotion started slowly in 1977 and was sharing some courses with Computer Science students.

As a Mathematical specialty, OR is always attracting the majority of students in the second year among the four Departments of the Faculty of Mathematics.

OR training started in 1978 with about 12 students from which just two girls. Nowadays the girls are the majority and are more than 60% in the actual OR classes.

The DES an engineer programs were followed by a Magister degree. This Magister was mainly dedicated to preparing doctorate students, even if some of them get jobs in companies. This program attracted about 10 students every year.

It lasted until 2005; the year Algeria comes to the international LMD education system. Under the LMD system, the OR Department of USTHB has more than 150 students in the Master degree today, not taking account of other Algerian Universities.

3.3. Careers: The first graduated students found themselves in nice opportunities to attend companies. The engineers were appreciated and the majority of them found jobs quickly after graduation. They were recruited in many areas of Economy, including Airline National Company, national and international Petroleum Companies, big Multinational Companies, Banking and Insurance Companies, etc. Some of the graduated students were sufficiently motivated as entrepreneurs to open their own start-ups, against strict complicated and bureaucratic regulations.

The Algerian OR graduated students are recruited in public and private sectors. Hundreds of them are also working in foreign countries (France, UK, USA, Canada, Middle East, Singapore, etc.). They are either appreciated in companies or in research and teaching places.

This is a very indicator which confirms undoubtedly the attraction and the success of OR training in Algeria.

Unfortunately, I was not able to find a study or statistics on the impact of OR neither in the Algerian Economy nor abroad, even if this will be a valuable and interesting information.

3.4. Examples: I will limit myself to the subjects of the graduating memory at the end of the engineer or the master programs, while the doctorate subjects are much diversified. These works may be roughly classified as follows.

Big companies' problems: Transportation of Goods and Fuels Distribution, Location of Fuels Depot, Vehicle Routing for Air Algérie, Inventory Management or the Algiers Refinery, Optimization of Maintenance of Equipment, Risk Analysis at ANNA, etc.

Small and middle companies' problems: Optimization of Falls in an Aluminum Joinery company.

Banking and Insurance companies' problems: Operational Risk Management, Credit Optimization, and Investment Risk Analysis.

Telecom companies' problems: Quality of Service Optimization (mix of Combinatorial Optimization and AHP), Optimization of Bandwidths Management, (AH) MCDA/MCDM.

4. Conclusion: OR for the Mediterranean Sea

4.1. What Happened: This is just an overview of this experience because our main goal is to show that it is possible to extend and develop it to our Mediterranean Region. Algerian cooperation experience shows clearly that it was a very successful *Transfer of Scientific Technology*.

For the sake of history, let us recall that, after WWII, the first OR international cooperation was the Tripartite meeting between USA, Canada and UK armies OR Groups in 1949, 21 – 29 April in London.⁴ Today a numerous specialized international meetings are held around the world. Many Algerians are in continuous touch with colleagues around the world. I give only the example of Pr. Bouroubi who is in personal contact with the Turkish academician Pr. Ekrem Savas for many years.

How about Mediterranean OR cooperation?

4.2. The Proposal: The example of Algeria just presented proves also that sincere cooperation programs may be successful and beneficial to all partners.

All the preceding multilateral and bilateral cooperation examples and more can be, in many other ways, adapted to a Mediterranean cooperation program. This program may have diverse nonexclusive directions. It could be training for students or academics. It may also be a common research planning, either fundamental or applications oriented. These applications may be, as a very priority, the problems which the Mediterranean Sea faces. The increasing savage pollution of the entire area of the Sea, the extinction of species or the transportation may be one of the shared situations facing the Mediterranean countries. Studying and developing and protecting and exploiting the Sea are some ways for this huge possible cooperation.

My dream is to create a new dynamic movement for a Mediterranean cooperation based on OR and many other scientific fields to protect the future of our Sea, under the auspices of EMAN. To be realistic, it will be acceptable if this cooperation starts at a bilateral level, extending itself at will for those aspiring to get involved. I am

⁴ S. H. Shrader, *History of OR in US Army*, 3 Vol., Washington: US Government Printing Office, 2006.

sure that there are at least two countries who can start this very challenge because it concerns all of us and it is neither political nor dependence based, but just applications of OR technology and sciences to the Sea. OR was used for WAR operations, let us use it for PEACE operations in our Sea!

References

Rosser, J. B., “*Mathematics and Mathematicians in World War II*”, *Notices of the American Mathematical Society*, 29, (1982), pp. 509-515.

Shrader, S. H., *History of OR in US Army*, 3 Vol., Washington: US Government Printing Office, 2006.

Tutte, W. T., “*Lectures on matroids*”, *Journal of Research of the National Bureau of Standards Section B*, 69, (1965), pp. 1-47 .

White L., Smith H., Currie C., “*OR in Developing Countries: a review*”. No known origin.