

## Why Are All the Softies in Europe? A Discussion of the Lack of Penetration of Soft OR in the US

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### **ABSTRACT**

*Soft Operations Research (OR) methods are used for a variety of real-world problems due to their focus on qualitative or interpretative problem formulation and analysis. Analysts use Soft Systems Methodology for problem structuring, drama theory for understanding conflicts, and morphological analysis for decision support. These techniques have an advantage over their quantitative counterparts because they can be used to tame wicked problems. So why is the use of soft OR not widespread in the US? In this paper, we discuss the systems and forces in place that limit soft OR within the US' higher education system and, by extension, the US' OR labour market. We discuss the failed attempts to buck this trend and the consequences of continuing with the hard OR-focused status quo.*

### **1.0 INTRODUCTION**

“Problem solvers have been approaching complex problems using a predominantly technical perspective to address complex problems since the advent of large-scale systems in the fledgling radio, television, and telephone industries in the United States during the 1930s” [1] but, as World War II erupted, both the US and UK military used a large number of these problem-solving scientists and engineers to help solve complex logistics problems to support their country’s war efforts. This effort contributed to the philosophy and techniques of the field known as Operations Research (OR). Unfortunately, while the problems faced by OR practitioners and academics alike have continued to evolve over the last seventy years, many antiquated techniques for addressing these problems remain. To address modern complex problems, the authors argue that increased adoption of a class of techniques known as soft OR is necessary to complement traditional OR techniques.

We begin our discussion with an introduction to soft OR. We then discuss why soft OR is failing to gain a foothold, especially in the United States, and we provide a historical perspective on how this situation came about. We then address what the consequences of this omission means, and what may be done to correct course and adopt a more inclusive set of techniques in wrestling with truly complex problems. It is the hope of the authors that the reader will join the fight after reading this paper and take up intellectual arms in an effort to broaden the use of soft OR in the US and abroad.

### **2.0 WHAT IS SOFT OR?**

Before soft OR can be defined, OR must first be defined. There is much confusion around the definition of OR, starting with the name itself, as different terms are used to describe the same discipline; for example, in

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the military domain, it is called Operations Analysis, Operational Analysis, or Operational Research. Since this paper focuses on general (i.e., non-military) OR in the US, we will use the term preferred in the US, Operations Research. Like its many names, OR has many definitions. We define OR as “giving analytical support to the decision-maker” [2] or “the discipline of applying advanced analytical methods to help make better decisions” (<http://www.scienceofbetter.org/what/>). However, these are not the only definitions of OR; for example, the Office Professional's Guide defines OR as “the application of scientific principles to business management, providing a quantitative basis for complex decisions” [3] and some have just equated OR to mathematical optimization<sup>1</sup>. Thus, there is an unconscious debate within the OR community as to whether OR is purely quantitative (even simply optimization) or it encompasses all analytical techniques, including those that are both quantitative and qualitative in nature.

For those that work with wicked problems [4], or problems in complex adaptive systems [5] or systems of systems [6], the notion that someone could generate an “optimal” solution to their problems might be amusing. In fact, as it pertains to these wicked problems, it has been proposed that optimal solutions are not only unattainable, but they are unnecessary [7]. So-called wicked problems are problems which are hard to solve because they lack complete information, their feasible solutions are not testable, they are unique, and how we understand the problem is based in part on how we want to solve it [8]. Further, there are likely multiple, possibly divergent perspectives on the problem and its resolution [9]. Wicked problems such as climate change, global conflict, and world hunger exist, and decision-makers need to decide how to handle them. But, if we accept the premise that OR is only optimization, then what academic discipline supports decision-makers faced with these wicked problems? We cannot think of a discipline and we believe that operations researchers should not shy away from such problems because they do not fit the optimization paradigm.

So, what is soft OR? Using our first definition of OR, soft OR is simply OR techniques that use qualitative or interpretative analytical techniques to support a decision-maker, whereas hard OR is mathematical or quantitative analytical techniques. Examples of soft OR techniques include Soft Systems Methodology [10], cognitive mapping [11], and Strategic Options Development and Analysis (SODA) [12]. These techniques will not be explicitly described here but an overview of them can be found in Hester et al. [13]. Other emerging techniques include Morphological analysis [14] and Drama Theory [15]. Any qualitative technique, e.g., ethnographical analysis, could be used as soft OR approach depending on the problem.

Soft OR techniques, of which problem structuring is a part, should be thought of as working in concert with hard OR techniques and not against them. Generally, “soft OR methods are those that structure a problem, as opposed to hard OR that seeks to solve it” [16]. It can be difficult for a decision-maker to determine what the problem actually is (the focus of problem structuring) and this difficulty is the motivation for the development of a great deal of soft OR approaches [2]. This problem of actually defining problems has led to much discussion in the academic literature, for example, messy problems [17], wicked problems [4], and Complex Adaptive Systems [18].

Beyond problem structuring, qualitative issues can be important to decision-makers and should be considered in any analysis of the related problem. For example, the Coca-Cola Company had to reverse its introduction of “New Coke” because of a resultant loss in revenue, which was due to consumers’ purchasing habits changing because they felt a sense of bereavement from the loss of the old product [19]. This phenomenon, found by Coca-Cola, is a qualitative issue and no quantitative technique would have uncovered the underlying issue.

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<sup>1</sup> “Employing techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization, operations research arrives at optimal or near-optimal solutions to complex decision-making problems.” (<https://www.informs.org/About-INFORMS/What-is-Operations-Research>).

Though useful to the decision-makers, the use of qualitative techniques seems to be very limited within the Operations Research literature, especially in the US. The following sections discuss how this lack of use occurred.

### **3.0 WHAT IS THE PROBLEM?**

In recent years, it has been commented that academic research, in the OR domain, is not used by practitioners. Tang said that the “returns on Operations Management [a field related to OR] research effort appears to be low” [20]. Pfeffer and Fong argued “that there is little evidence that business school research is influential on management practice” [21]. The authors continually meet practitioners that used to read the OR journals but have given up due to a perceived lack of benefit. Unlike other academic domains, which can be studied for their own sake, OR is a practical subject that should be used. The authors would, therefore, argue that academic OR is there to support the practitioner OR community, but this does not appear to be happening. There is a disconnect between the theory being produced in academia, and the need experienced by practitioners.

The theories and methodologies being produced in academic OR literature are impressive feats of technical and intellectual prowess. However, these tools and methods are not the ones required by the practitioners. The academic OR community is guilty of committing Type III errors [22] in that they are “building the wrong models” and thus solving the wrong problems. In an effort to demonstrate their new quantitative methodologies, academic operations researchers make limiting assumptions to the underlying problems they are trying to solve. These limiting assumptions reduce the efficacy of solutions for those actually trying to solve the problem. Examples of these limiting assumptions include assuming zero delivery time in manufacturing models, or assuming that humans are expected utility optimizers (even though this has been shown incorrect through Allais’ paradox [23] and the Ellsberg paradox [24]). As Tang put it, “results are not insights unless they lead to some real implications about a real [OR] problem.”

Not every problem can be solved with a mathematical model and it is not obvious what every problem actually is, as highlighted by Heyer: “In the 1970s, 80s and 90s, it had become obvious that some [organizational] problems could not be solved by pure logic, employing hard OR. Indeed problems have continued to become more complex and increasingly difficult to model mathematically” [16]. Soft OR can help provide both problem-structuring and qualitative information, e.g., survey data collection, to an operations researcher whom is faced with a complex problem. However, “there is a contingent of researchers and practitioners within the operations research community that do not consider soft OR to be ‘real OR’” [25], especially with the US.

### **4.0 HOW DID IT COME ABOUT?**

Given the increase in complexity of problems that we are facing, the obvious question is “why has problem-structuring (soft OR) not been embraced?” To use soft OR techniques implies some training in those techniques and “the skill set required is not traditionally taught in OR education, at least within the United States” [25]. Most OR is taught at the university level and academic faculty are in charge of their respective curricula; they choose not to teach soft OR. Reasons for this exclusion arise from three unique domains: academia, journal publication and accreditation.

#### **4.1 The Business of Academia**

The business of academia revolves around peer-reviewed journal publication. Academics must “publish or perish,” which means that their continued success relies on the publication of peer-reviewed articles in respected

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journals. At some level, this is great news because it means that academics are forced to publicly release their research. However, there are two concerns with this. The first is that “in a world of global academic input and innovation, the volume and complexity of available information and tools in any given field rightly overwhelms the practitioner. As an example, in the health care domain there are 750,000 academic articles published each year” [26]. The second concern is the audience for whom academics are writing for in the first place.

It can be argued that academics write journal papers for other academics and not for practitioners. Tang pointed out “we [academics] write our research articles by targeting this “special group” without much concern about the readability of the paper by OM [operations management] practitioners” [20]. The reason is that other academics might cite an article they have read and citations are the quantitative measure used to rank papers, academics, and journals. Examples of these rankings include the impact factor and H-index, which both measure the number of times a paper/author/journal is cited in other journal articles. Since practitioners rarely write journal articles, they do not aid the academic in increasing their citations and, therefore, their rank. Rank is not just a matter of prestige, as it helps academics get funding, tenure, and, in some cases, a wage bonus. More funding means more research, and more research means more articles to publish.

These ranking metrics are used in a similar fashion across all academic fields. It does not matter if a citation to your article comes from an academic working in middle-English literature or neuroscience. Thus, if you market your academic article to a field of study that has lots of academics working in it, you are likely to get more citations for that article. OR is a relatively small field with only a few scores of departments in the US, so writing articles for academics in related fields, like applied mathematics and economics (which have departments in virtually every US campus), means a greater chance of citation of your articles.

Not only do OR academics have an incentive to write for a larger subject audience but the larger theoretical subjects have an incentive to write in OR journals. The public, via Congress in the US, have been concerned about the ivory towers of academia and its perceived lack of practical application. There is a requirement to demonstrate the potential broader impacts of research to obtain funding dollars. Thus, purely theoretical academics are trying to make their research look more practical in a bid to obtain funding. One easy way to do this is to try and label your research under a practical subject’s banner, like OR. Thus, the OR journals have been invaded by theoretical academics, from fields such as applied mathematics and economics, over the last twenty years and whose theoretical papers are of little interest to the practitioner.

As the theoretical academics start publishing in the OR journals, they start joining the journal boards and acting as reviewers for those journals, which, in turn, makes those journals more attractive to the theoretical academics. Thus, the OR journals, and societies, have slowly been taken over by theoretical academics. These individuals also bring with them their own worldviews of conducting science, which is not necessary in the spirit of OR.

### 4.2 The Business of Journal Publication

Why are the journal publishers not stopping this takeover? This is answered by understanding the journal publication business model. Journals are ranked in a similar way to articles and the more a journal’s articles are cited, the more prestigious the journal becomes. A more prestigious journal is likely to appeal to a wide audience of academics. Publishers want their journals to appeal to wide audiences because journals make money through library subscriptions and the wider the audience the more likely the journal will be subscribed to in a university library.

Practitioners tend to work for organizations that do not have large libraries. Academics work for organizations (universities) that do have large libraries with large budgets (a requirement for accreditation in some cases).

Journals tend to be sold in packages of journals (a bit like television subscriptions), and if a publisher can place a small subject's journals, like OR, into a larger package, like applied mathematics, then the small subject's journals help sell the package. Who decides which package a library will purchase? University library committees, which tend to be made up of academics. A larger field is likely to have more academics involved in library committees than a smaller one, so publishers wish to appeal to larger fields. A publisher can also appeal to larger fields by allowing the larger field's work to appear in as many of their journals as possible.

Thus, publishers have an incentive to make their journals appeal to larger academic fields in a bid for prestige and subscription dollars. Pieters and Baumgartner showed that OR discipline articles are rarely cited by other business or social science disciplines [27], which is not attractive to publishers. This results in publishers closing down those journals. For example, a few years ago saw the end of *OR Insight*, a journal focused on the OR practitioner, after 26 years of publication. Ultimately, OR journals must accept articles from other fields, like applied mathematics and economics, to remain in the good graces of the publishers and increase their rankings. OR academics may wish to publish in these highly ranked journals because of the way those academics are assessed, for example, using the UK's Research Excellence Framework (REF) assessments.

OR departments are more likely to employ individuals who publish in high ranking OR Journals and who are complimentary to existing department members. Articles that appeal to a larger audience are more likely to get published in top OR Journals. Authors who write their articles for larger fields, like applied mathematics and economics, will reach a larger audience. Authors with background in larger fields are more likely to be able to write publishable articles in that field. Thus, OR departments are incentivized to hire individuals with a background in the larger fields and a feedback loop is formed in the employment of academics within OR departments. The result of this is that OR departments have been taken over by individuals that have not been trained in the philosophy of OR and they will impose their own subject's philosophy on an OR curriculum. In the case of applied mathematics and economics, this scientific philosophy is one focused solely on the use of quantitative approaches.

In developing a methodology, it is reasonable to ask how good that methodology is at serving its intended purpose. Quantitative techniques can be measured at some level: algorithms can be given scores using asymptotic notation, simulation results can be compared for accuracy against numerical measures from real-world data. Qualitative techniques do not have that precision; for example, how good is Soft Systems Methodology at problem structuring? For those that are quantitatively trained it is difficult to accept methodologies that are not directly measurable. Without a way to judge soft methods, quantitative researchers are uncertain if the methods are "gold" or "snake oil." For example, fancy graphics can be useful for explaining analytical results to a decision-maker but they might also mislead them as well [28-30]. Thus, as academic OR becomes more quantified it is less likely to accept qualitative techniques.

### **4.3 United States of America and Accreditation**

The arguments presented above could be applied to academic OR as a whole and not just the US. However, US academia is different from other countries and this difference has accelerated the feedback loops discussed above. The key difference is accreditation.

The US has a lot more academic institutions per capita than other countries. For example, the US has three times as many degree-granting institutions per capita than the UK<sup>2</sup>. Both the US and UK have a significant number of overseas' students as well. Of the US institutions,  $\frac{3}{4}$  are private including for-profit institutions such as Trump

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<sup>2</sup> The US has 2,474 four-year degree-granting institutions serving 300M people. The UK has 159 higher education institutions, excluding further education colleges serving 60M people.

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University. Thus, the competition for students is much fiercer in the US than in the UK. There is a demand for strong academic programs and departments to distinguish themselves from the weaker competition at other universities. This is achieved in the US through accreditation. Accreditation of an academic program is granted by accreditation organizations, which tend to be private or non-profit organizations such as Southern Association of Colleges and Schools (SACS) and Accreditation Board for Engineering and Technology, Inc. (ABET). These accreditation bodies tend to follow very strict guidelines.

Operations Research departments are judged, through the accreditation process, on how well they demonstrate the accreditation organization's criteria. As most OR departments in the US are organized under engineering colleges, they are judged by engineering standards used to evaluate similar subjects such as systems engineering or industrial engineering. Engineering tends to be a quantitative discipline<sup>3</sup>, and thus, qualitative courses and faculty with qualitative higher education degrees will be considered unfavorably. Hence, accreditation represents yet another reason why US OR academic departments favor quantitative academics, which result in quantitative courses, a quantitative work force, and quantitative academic literature.

### 5.0 WHAT IS THE CONSEQUENCE?

It is the authors' belief that the takeover of OR departments by quantitative academic fields will result in OR becoming less and less relevant in academia because it does not distinguish itself from the quantitative fields it draws from and thus, it might be seen as duplication. This result has already started to happen; the National Science Foundation no longer has an Operations Research program as OR has been absorbed into its "Service, Manufacturing and Operations Research" program. It looks like the OR practitioner community has turned its back on academic OR as well, with  $\frac{3}{4}$  of the Institute for Operations Research and Management Sciences (INFORMS) membership now coming from academia. With both the practitioners and the wider academic community turning its back on academic OR, will it survive long into the twenty-first century? Without academic OR departments to train the workforce, will OR survive?

### 6.0 WHAT CAN BE DONE?

Academic OR needs to become more relevant again to the practitioner, which, in turn, helps OR become a more useful tool for solving the world's wicked problems. We assume that OR practitioners want better techniques for conducting their business and ask the question: how do we link up the research done in academic OR with practitioner OR problems? Examples of academics that bridged the practitioner-scholar gap exist, so it is possible. For example, Prof. Barber was instrumental in forming the global parliament of mayors [32].

Some believe that the key to bridging the gap is OR academics' researching and teaching the whole OR experience, including problem structuring and other soft OR techniques. For example, Mathieson argues that OR needs to get back to its multi-disciplinary roots in his book "Knots, Lace and Tartan" [33]. Mathieson was of the belief that using multi-disciplinary approaches makes for stronger analysis in understanding and solving the world's problems; this approach was echoed by Collins and Frydenlund [26] and Hester and Adams [1]. Efforts to do this have been made; for example, the authors are trying to introduce soft OR to manufacturing prognostics and health management [13]. This is unlikely to succeed on a massive scale due to the issues raised above about the forces in play in academic OR.

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<sup>3</sup> Though some are making an effort to change this: [31] D. I. Blockley and P. Godfrey, *Doing it differently: systems for rethinking construction*: Thomas Telford, 2000.

Royston argues that the academics-practitioner bridge can be overcome with more partnerships between the two groups [34]. This requires each group to understand the needs of the other. Teaching faculty are usually on nine-month contracts, so they are able to take summer internships with industry to understand them better. This is not simply that academics need to understand the problems of practitioners but that practitioners must understand the environment that academics work in. It is not adequate to say “solve my problem,” no matter how noble the cause.

An additional suggestion to bridge the academic-practitioner bridge is improved communication between the two groups. Westermann calls for more visualization techniques in OR [35] to help practitioners understand the complexities of the methodology used. However, the use of visualization is not without its critics [36, 37].

## 7.0 CONCLUSIONS

OR has the potential to help decision-makers change the world for the better, but only if they have the right tools. Qualitative methods, like soft OR or visualization, tend to be ignored by academics, which, in turn, means that these methods are not included in OR practitioner’s training (typically at the postgraduate level). There are some that naively believe that quantitative approaches will pick up any information that a qualitative approach will; Anscombes’ Quartet [38] is an example of this not being the case. Soft OR provides tools for practitioners to complete the whole OR experience, including problem structuring and stakeholder analysis.

This paper discussed some of the reasons why soft OR is not accepted in academic departments, especially in US schools. These reasons are related to journal publication and accreditation. The paper also argues that, for similar reasons, academic OR is on a self-destruction path. Academics are required to produce more and more complex quantitative techniques, which, as Westermann puts it, “results in an increasing gap between the embedded science and influence capabilities of the [practicing] analysts” [35].

Maybe OR departments will all be replaced by analytics departments in the future. This would be a sad loss, as analytics is only part of the whole OR enterprise.

Some solutions to these problems suggested a bridging of the academic-practitioner divide. However, neither side really has the incentive to do so as neither side has the will to understand the problems the others face.

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