CHAPTER 5

FUTURE RESEARCH AND CONCLUSIONS

"The electrical power deregulation plan has not yet been implemented in Ghana. They are currently struggling with some political issues. Now, we are beginning to work on a restructuring plan for Nigeria, which is about six times larger than the Ghana problem." *December 20, 1999*

Mangesh Hoskote
Energy Restructuring Specialist
The World Bank

"…some interesting stuff on the electric power industry is beginning to emerge here…the field should be a-poppin' for a while, with lots of opportunity for research, consulting, fame, and fortune!" *March 15, 2000*

Mariann Jelinek, Ph.D.
Program Director
National Science Foundation

"The amount of research interest in GAs does not yet appear to have peaked, and there are clearly many inviting avenues still to be explored. Perhaps the most interesting developments will arise from two areas. First, a more intensive study of the connection of GAs with other methods of neighborhood search. Second, an exploration of the implications of the No Free Lunch theorem …with existing GA theory." *Summer 1997*

Colin Reeves, Ph.D.
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FUTURE RESEARCH

Throughout the previous chapters, we have pointed out circumstances that we believe would be potential paths for future investigations directly related to the empirical studies performed herein. It is not our intent in this section to revisit those items previously identified. Rather, we wish to highlight areas of future research that we see as new and exciting extensions of our work.

Human Organ Transplant Districts

In the United States, there is an ongoing public policy debate about the allocation of human organs from donors to recipients. The demand for organs by far exceeds the available supply, with approximately 20,000 organs available and more than 60,000 hopeful recipients on the waiting list (Koch 1999). The U. S. transplant community is coordinated by the United Network for Organ Sharing (UNOS). Their primary mission is to match waiting recipients to organ donors 24 hours a day, 365 days a year, while ensuring that all patients have a fair chance at receiving the organs they need. UNOS has identified the following objectives to accomplish this goal:

1. Maximize the availability of transplant organs by minimizing discards
2. Maximize patient and graph survival
3. *Minimize effects related to geography*
4. Minimize overall transplantation related costs

Issue number 3 is a multi-criteria districting problem that is similar to the EPDP that we characterize and solve in this research. In an ideal (fair) world, the allocation policy for organ transplants should be independent of the geographic region in which a recipient lives. Realistically, it is not possible to distribute organs using a single national waiting list. Attempting to do so would result in organ damage or waste and ultimately fewer successful transplants.

Defining the smaller geographic regions that comprise an organ distribution area has a tremendous amount of hidden complexity. Differences in population density largely impact donor availability and waiting list length. The issue is further complicated by the fact that each organ has a different acceptable level of ischemia time (time without oxygenated blood) as well as a multitude of other medically driven constraints. Thus, we point out that this problem represents a worthy extension of the solution techniques that have been derived from our efforts. The policy of UNOS is to make data available on request to anyone who asks for it so that scientists, physicians, policy makers, and patients can make well informed decisions (Unos.org, 2000).

Public School System Redistricting

Recent federal court rulings appear to signal an end to race-based assignments of students to school districts throughout the U. S. As an example of this, "Wake County (Raleigh, N. C.)

school leaders…were gearing up for the most complex reassignment effort since the early 1980s." (Silberman 2000). The federal courts have recognized that diversity among the student population is an important consideration in determining boundaries for school districts. However, the trend is moving away from defining diversity by race and moving towards other criteria. The new diversity criteria used in this specific case (and perhaps many others) are defined by family income and academic achievement derived from the national standard of learning test scores. Thus, again we are confronted with a multi-criteria districting problem. In the case of the Wake County Schools, Ramey Beavers (who is directing the assignment planning) was quoted as saying, "We've got a bunch of maps spread out now…but I won't hazard a guess on the number of students who might be included (in the reassignment)." Is it possible that their current approach will lead to a solution that is less equitable than if they had used a DSS such as the ones described in this research?

Although the school districting problem has been investigated in the research literature in previous years (Ferland and Guenette 1990) it continues to be an open avenue of applied research. In much the same way that the national census 2000 will breath new life into the political redistricting problem, we see these topics as viable areas where the work presented herein can be of great added value.

Deregulation of Electricity Markets in the United States

Deregulation is well underway in the United States, however, there is still a long way to go. Understanding the issues that unfold for the U. S. is critical if we wish to apply some of what we have learned in this research to the U. S. application. While the issues are sure to be different in the case of the U. S. than for third world countries (which is the specific concern of the World Bank) it is reasonable to expect some overlap to exist. Thus, we believe that the work performed in this research has some future applicability to the U. S. market and view it as a potential extension of our work.

For the curious reader interested in the current status of the U. S., we provide a cursory overview. The Retail Energy Deregulation Index (RED Index) is the leading indicator for the deregulatory status of independent states in the U. S. A RED Index score of 0 represents the monopoly model while a score of 100 represents a complete implementation of a competitive model. Leading the way with a score of 59 and 58 are Pennsylvania and New York respectively. While California, the pioneer of the deregulation movement, currently ranks in 11th place with a score of 34. Virginia is ranked 46th with a RED Index of 4. The unweighted national average is 18, but when weighted by sales volume is 20.4, or when weighted by revenue is 23.3. (PRNewswire 2000). Indeed, there is much work to be done before we can hope to see any benefit from the deregulation initiative.

Revolutionary Computing

With the rapid progress in biomedicine that we are observing today as a result of technological breakthroughs, it is reasonable that we should expect breakthroughs to occur in the development of solution algorithms that are based upon biological models. We make no claim of a breakthrough as a result of the DNA based evolutionary model put forth in this research, but we believe that it represents a step in the right direction. For nearly three decades now, the basic biological model developed by Holland has remained relatively unchanged, despite the tremendous amount of variations to the model that have been implemented. This is testimony to the worthiness of his theories. If the purpose of research is to uncover the “truth” or develop increasingly better solutions to complex problems, then researchers must remain committed to developing more sophisticated techniques. We agree wholeheartedly with the statement by Reeves provided in the opening of this section. Research in the field of biologically inspired algorithms has yet to reach its peak.

CONCLUSIONS

We believe that one of the reasons the solution method presented in this research is effective is because it is independent of the utility function the DMs bring to the problem. When the Pareto set can be easily visualized (using the DSS), the DMs are able to choose a final alternative (from the population) without the rigor and uncertainty of utility assessment. We make no claim that our solution method is the best approach for all instances of the EPDP. Particularly, when other instances of an EPDP involves different objectives. Indeed, alternative approaches may be called for in certain cases. However, it is clear to us that the research described herein represents the effective application of a "state of the art" search technique combined with the latest technology in DSS to provide solutions to a very complex and real world problem.

With competitive electricity markets emerging throughout the world, it is necessary to develop effective solution methods (systems and algorithms) for designing power districts. This research represents an initial attempt to characterize the EPDP. Specifically, we identified similarities and differences of EPDPs with other districting problems, and developed a DSS that is effective in finding acceptable solutions. The motivation underlying this research was to develop an effective tool for the members at the World Bank for solving Ghana’s EPDP, with the intent of extending the model to other countries as deregulation takes place around the world. The true contribution of the DSS rests upon the perceived value that it provides to the members of the World Bank. It is our hope that the DSS will evolve beyond the initial design, as we believe that this will foster a healthy ongoing research relationship with one of the most significant players in the global economy. In addition, we hope that it will provide us with the opportunity to make a significant contribution to society.