

APPLICATION OF HAEKEL'S THESIS TO ABSEL DEVELOPMENT

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ABSTRACT

In this paper the authors use a model of embryonic development proposed by Haekel to retrace the development of the DECIDE simulation and the development of several key evolutionary stages of ABSEL research. The paper highlights four distinct development stages that the DECIDE simulation went through including; (1) the Demand Functions, Fortran (or BASIC), Mainframe Computer, and Hollerith Card Era, (2) the Administrator's Summary Sheet Era, (3) Decision Input and Decision Support Systems Era, and the (4) the Artificial Intelligence and Expert Systems Era. Following Haekel's Thesis the same four evolutionary stages are detailed for ABSEL research.

INTRODUCTION

In 1866, the German zoologist, Ernst Haeckel, (1905), proposed that the embryonic development of an individual organism (its ontogeny) followed the same path as the evolutionary history of its species (its phylogeny). Scientists have shortened his proposal to the statement—"Ontogeny recapitulates phylogeny." Although the merits of Haeckel's proposal are open to dispute, it is ironic that Haeckel's theory may provide a useful framework to appreciate the development of an individual computerized business simulation, DECIDE (Pray & Strang, 1981), and the evolutionary developmental stages of the research focus of ABSEL. In the metaphorical case, ontogeny is represented by the DECIDE simulation and phylogeny is represented by ABSEL research. This paper presents the parallels between the development of the DECIDE simulation and the evolution of ABSEL research.

BEGINNINGS:

If ABSEL members can relate to, and sometimes with a great deal of nostalgia remember, some or all, of the stages of evolutionary development, then the purpose of this paper will be achieved. In order to attempt to achieve that goal, the author has chosen to reflect upon and personalize the typical standards for presentation of scholarly papers and hopes the resulting style will not prove offensive to the more traditionally oriented readers.

In the 1970's, I was a freshly minted assistant professor entrusted with the responsibility of teaching my students the

principles of management while struggling to establish myself as a capable instructor so that I could advance to academic nirvana, tenure. Although I found myself to be brilliant, informing, charming, etc. (you get the idea), I discovered that all of my students were not enamored with my management classes. I, of course, was perplexed. Fortunately, I had the good sense to consult others about options for my instruction. One of my colleagues, who I deemed to be far less engaging than I am, had had phenomenal preliminary success using a computerized simulation in his management class. (He was using Babb's Supermarket Simulation, Babb 1969).

At that point, I faced two challenges; I refused to be outdone by colleague and I had no intention of adopting a **supermarket** game. (It turns out that my colleague had earned his Ph.D. from Purdue, the institution where Babb had initiated the use of the Supermarket Game.)

After hastily reviewing the available simulations, I adopted Henshaw and Jackson's *EXECUTIVE GAME* (Henshaw & Jackson, 1969) and, as the saying goes, the rest is history. My students loved the simulation and could not get enough of it.

DEMAND FUNCTIONS, FORTRAN (OR BASIC), MAINFRAME COMPUTER, HOLLERITH CARD ERA OF SIMULATIONS:

If you get a group of older ABSEL members talking about the good old days, the discussion often includes things like FORTRAN (or BASIC) computer programming, Hollerith cards, and trips to the university's computer center. They also talk about the enigmatic run time errors that writers of software, including simulation developers, experienced daily in their struggle to create computer-based simulations. The state of computer technology in the 1970's was that of mainframe computers located typically at one central point on a campus, Hollerith (keypunch) cards generated by IBM keypunch machines, and programs based upon either the Fortran or the BASIC computer language. I have often marveled at how much was accomplished under those primitive conditions. And to further exacerbate the challenges, I would remind the reader that the student instruction manuals that were created to lead users through the simulation procedures and processes were likely to have been generated on TYPEWRITERS, with all the attendant challenges associated with that technology. There are many things that could be said, but one thing that is absolutely clear is that simulation developers in that era were resolute people with

an exceptional commitment to the challenges associated with software development under those primeval circumstances.

It was in this environment that the first seeds of DECIDE (Pray & Strang, 1981) were planted. At that time, Tom Pray and I were fresh out of our doctoral programs and were in the first years of our teaching careers. Like most new faculty we had tenure at a college or university as a short-term goal. Although both of us had had success using the *EXECUTIVE GAME* in our classes, there were aspects of that game that we found to be limiting. As a result, Tom and I decided to create our own computerized business simulation. We decided to call our game ADSIM, a shortened version of Administrative Simulation. Both Tom and I had had formal training in Economics and utilized that background extensively in the creation of the basic demand functions which are the central core of any general business simulation. It is not a surprising outcome that in the years since the creation of ADSIM Tom has been involved in numerous research projects involving the “black box” (i.e. the underlying demand function of a simulation). One might argue that Tom Pray, Steve Gold, Dick Teach, among others, have built their professional careers on research focused on demand functions. There are literally too many citations to allow for an exhaustive listing but a sample more of the notable research papers would include: Gold & Pray in 1982, 1984, 1990, 1997, 1999, the work of Teach 1984, 1985; and most recently, the work of Goosen, 2008.

In the 1970s and 1980s, many ABSEL research papers at least tangentially addressed the issues relating the technology that was used by to drive simulations. As an example in 1975, Lord felt obliged to indicate that the model utilized in the *V. K. GADGET COMPANY* was written in FORTRAN and required about 32K words of memory for execution. Similarly Churchill (1974) in describing his small-scale deterministic business game indicated that the simulation which was originally written in BASIC and was modified to run in Fortran IV. He also detailed the hardware requirements including a card reader, line printer, capacity for a 559 statement program, and space for 538 dimensioned storage locations. Culley (1974) felt the need in his discussion of ADMAG I to indicate that it was written in Fortran Extended and easily adapted to many computers where FORTRAN compilers were available. He also discussed issues relating to the availability, or lack thereof, of punch facilities. In 1974 Barton suggested including game parameters and controls in a program written in FORTRAN to help potential game developers. In 1981, Barton emphasized in his description of IMAGINIT that users needed a medium-sized computer and needed to use a master FORTRAN version. When was that last time that an ABSEL research specified those needs?

In 1977, Gentry and Reutzel in describing the basic game that was being used at Kansas State University found it significant to report that the game was written in FORTRAN, rather than BASIC due to availability considerations. Clearly, ABSEL research was in its embryonic stages and was experiencing all of the ‘stops’ and ‘starts’ one would expect to find at this stage.

Tom and I experienced setbacks and challenges as we developed and fine-tuned ADSIM. Perhaps, one of the most memorable, although not necessarily monumental ones was a response that we received when we elicited student feedback about ADSIM during the early years of its use. Since we were

eager to find problems and make corrective changes, we surveyed our students at the end of each semester’s use of ADSIM to get their reactions. We, of course, **knew** that ADSIM was a creation that rivaled the electric light bulb and sliced bread. As a result, it was much to our chagrin when one of the student’s reaction to our game was captured in his/her assessment, “What a stupid game, I skipped class.”

ADMINISTRATOR’S SUMMARY SHEET ERA OF SIMULATIONS:

ADSIM was beta-tested in an Introduction to Business class in the summer of 1978. The original manual was a mimeographed document (yes, which was the light-blue image that was created by placing a master on a drum-like machine that exuded noxious odors). The beta-testing went remarkably well with some notable exceptions. For example, most of the key functions that were the integral components of the basic ADSIM model were continuous mathematical functions. The stock market function although reasonably complex, ultimately generated a stock market value that was pegged at \$60 but was allowed to move up and down depending on team performance. This worked reasonably well for the first several periods of simulation play until it was discovered that one team had performed so poorly that their stock market value had gone **negative**. How embarrassing for us simulation developers! Negative numbers are no problem for a continuous mathematical function but make no sense as a stock market price. To make matters worse, one of the team members on this team that obviously was performing poorly was an older non-traditional student who had been vocal in her criticism of the game for most of the semester. So, we had to quickly solve the problem of the negative stock market value before we returned the results for that period of simulation play. After a brief consultation two adjustments were made to the stock market function, 1). an exponential dampening function was added to the function and 2). an if-then statement was added to the FORTRAN code that simply reported to the players that their stock had been *taken off the big board* if their stock market value fell below \$10. As a result of several changes to the source program, our disenchanted student was denied the opportunity to find additional fault with the game.

After a brief period of beta-testing in our own classes, several other instructors at our institution agreed to use ADSIM experimentally in their classes. At the same time, a colleague, Richard Butler, a formerly active ABSEL member, who was teaching at a nearby college agreed to use ADSIM in one of his courses. After using ADSIM for a brief period of time, Richard suggested that it would be a great idea if during each period of simulation play the instructor/administrator had available a one-page summary sheet that encapsulated all of the key team decisions and results. He suggested that the summary sheet would allow the instructor to go into class and conduct a meaningful debriefing without having to sift through a large number of sheets of computer printout. At Richard’s suggestion, a one-page administrator’s summary sheet was created.

Given the thesis of the article, it would great to report that there have been numerous articles discussing administrative summary sheets in the ABSEL literature. Nonetheless, this topic has been discussed by ABSEL scholars. As early as 1984, Fritzsche mentions the use of an instructor’s summary which

made it possible to “track the progress of the firms.” Teach (1990) makes mention of the instructor’s summary in his writings that address designing business simulations. Biggs (1990) suggests the significance of an administrator’s summary report in his chapter, “A Review of Business Games.” So, although it has not been a major theme, yet again, the ABSEL researchers have traced through a theme that is associated with a development of ADSIM.

For a year or two several other instructors in various universities heard about ADSIM by word of mouth and adopted it. Finally in 1980, Random House publishing company offered to acquire the rights to ADSIM and publish it nationally. It was during that process that the name of ADSIM was changed to DECIDE. The name, DECIDE, is an acronym for Decision Exercises through Computer/Instructor Designed Environment. I still fondly remember the conversation during which the publisher explained that ADSIM sounded like an amateurish name made up by a couple of anxious college professors and DECIDE was a name that had marketing potential. So, DECIDE was born.

DECISION INPUT AND DECISION SUPPORT SYSTEMS (DSS) ERA OF SIMULATIONS:

One of the challenges of many of the simulations of that era was that of inputting the team decisions. DECIDE went through the many of the same development stages as other simulations. In the first generation, students entered their decisions on preprinted decision forms and presented the completed forms to the game administrator. The game administrator subsequently generated Hollerith punch cards and fed them into a card reader along with the FORTRAN source program.

For the second generation of decision input, a FORTRAN program was created which allowed student teams to enter their decisions directly into the college’s Vax Mini-computer. The decisions were saved, bundled with the other student decisions, and subsequently fed into batch runs for the DECIDE program. To facilitate student planning, as they wrestled with their decisions, sets of worksheets were provided. Worksheets in that era meant sheets of paper with blank spaces provided for the students to handwrite entries on the sheets. Students were expected to manually (presumably using calculators) fill in the lines of a worksheet to help them rationalize their decisions.

If the reader wonders why Excel spreadsheets were not employed, remember this was the early 1980s and PCs were just entering the market. During that period, the third generation of decision input did start to take shape. Using an Apple II+ and VisiCalc, the worksheets that had been used by students were put into a computerized spreadsheet. This allowed the students to easily perform numerous “what-if” scenarios. This process for DECIDE was paralleled by other game designers and ABSEL began the DSS period of its evolution.

As early as 1982, ABSEL researchers were beginning to extol the advantages that would accrue if DSS were incorporated into simulations. Dunikoski and Barton (1982) indicate seven different services that DSS provided for game administrators. It may be an indication that this was an early stage in ABSEL’s evolutionary thinking about DDS since Dunikoski and Barton do not focus their attention on what subsequently has become a far more significant virtue of DSS use in simulations; namely, the ability of students to perform numerous what-if scenarios. In

1985, Markulis and Strang proposed the use of DSS to encourage students to get beyond “seat-of-the-pants” decision making. They argued that the use of DSS alleviated two of the problems that had been associated with the use of simulations: 1) the lack of adequate time to make reasonable business decisions and 2) the failure of games to draw upon and integrate various concepts and techniques—particularly quantitative techniques that business students are expected to learn in courses.

In 1987, Krishnamoorthy et al. published an article that addressed: 1) the issue of data entry that had proven to be nettlesome for earlier simulation designers and 2) the difficulty in using “what-if” scenarios to test the ramifications of potential decisions for the DECIDE simulation. Clearly, this paper was also promoting the use of DSS by simulation players. In their paper they demonstrate how students used a worksheet that was written in Lotus 1-2-3 to facilitate what-if analysis and to alleviate many of the problems that previously had been associated with the data entry step of simulations. The Lotus 1-2-3 program that they used obviated the need for manual worksheets and card input that had the mainstay of many earlier simulations. Thus, DECIDE moved through the evolutionary stage of DSS in roughly the same period of time that ABSEL was moving through this evolutionary stage

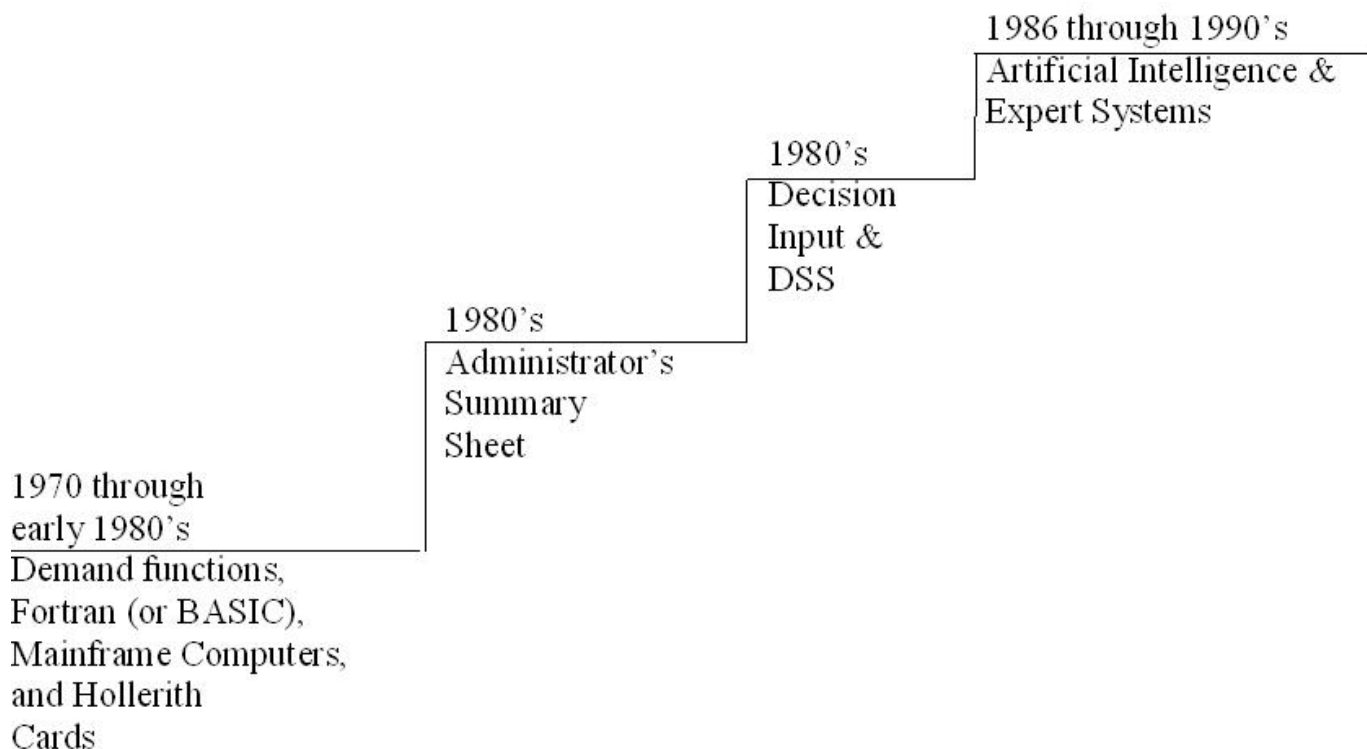
In 1986, Sherrell et al. reported on their experiences using a decision support system written in Lotus 1-2-3 on a microcomputer to support the use of the simulation, COMPETE (Faria et al. 1984), on a mainframe computer. They reported one of their several purposes was to “enhance the learning effectiveness of the simulation method.” One of Sherrell’s contributions was the movement of the DSS from mainframe computers to a microcomputer. It is appropriate to remember that microcomputers were in their state of infancy during the early 1980’s. So what might be thought to be less significant with today’s technology was an important evolutionary milestone in that era.

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS ERA OF SIMULATIONS:

In the second half of the 1980’s decade interest in expert systems started to influence the ABSEL research. In 1986, Teach suggests that “very fundamental artificial intelligence concepts can be incorporated” in a simulation process. Gum and McGregor (1987) discussed the tentative use of expert systems in a financial planning application. Also in 1987, Cannon and Morgan discussed the use of expert systems in a marketing case analysis, and Patz proposes open system simulations which he suggests are comparable to artificial intelligence and expert systems. Finally in 1987, Varanelli, et al. proposed the construction of the expert system model over stages and suggested their experiment will contribute to “the growing interest by the business community in the applicability of expert systems to business decision making.”

The enthusiasm for artificial intelligence and the use of expert systems was tempered by the realization of some practical limitations. Gautschi and Prasad (1988) relate their initial steps in the development of an expert system to be used with a business simulation program and point out that two of the limitations on the development of expert systems at that time had to do with the lack of access by students to PC’s and the growth of the technology on which artificial intelligence

Figure 1. Era of Development for Both DECIDE and ABSEL research



depended. As a historical benchmark, the reader is reminded that many of the PC's available at that time were IBM PC's and the IBM PC/2 series was just starting to become available. By contemporary standards the platform available for software development and use were primitive and limiting. It was probably these limitations that forced Dorr et al. (1988) to develop an expert system that was limited to the evaluation of internal controls as an aid in accounting information systems. As Sondak and Briggs (1988) stated it, "But few business educators have been exposed to the base concepts of expert systems or can appreciate the effect they will have on business."

In 1988, in spite of some of the limitations stated above, Sackson and Varanelli conducted an experiment in which they tested an expert system model developed to simulate group decision makers in a strategy development and policy making environment. At the time of their writing in 1988, Sackson and Varanelli indicated that their experiment had not yet been completed and, as a consequence, presented tentative results. Unfortunately, a perusal of the ABSEL literature indicates that Sackson and Varanelli did not subsequently present their final findings. So their contribution, although limited, advanced the use of expert systems in computer simulated environments. In 1989, Rajkurnar and Barton offered what could be viewed as a "call to arms" when they suggest that artificial intelligence techniques are necessary to guide the search process in the context of strategic thinking.

By 1990, several ABSEL researchers were making extensive use of expert systems. Rubin (1990) reports on the use of STATUATOR, which is an expert system designed to assist marketing research students select an appropriate statistical technique for a particular research problem and Barton et al.

(1990) relate their work using an expert system which was provided to business simulation game players. Although in their experiment, the use of the expert systems was voluntary on the part of the students, they concluded that the expert system showed value and was an aid in decision making. These are positive but certainly not very lofty pronouncements.

Since 1990, one can find occasional references to artificial intelligence and business simulations, but this certainly does not represent a major theme in the ABSEL literature during that period.

DECIDE came to the artificial intelligence/expert system evolutionary stage in 1996. In 1996, Pete Markulis and I reported their use of what we called a contextual software program (Markulis & Strang, 1996). The program was an expert system that helped "students learn and better understand the decision complexities which are part of a typical simulation." The program was written using a multi-media authoring package called, ToolBook. ToolBook is an object-oriented programming language that was created by Asymetrix Corporation. In the case of DECIDE, the ToolBook software that was developed was used to facilitate the ex-post analysis step of simulation play. The software program led the student/players through a series of steps that were designed to help them better understand why they had done so well, or so poorly, during the play of each period. So with the development of "artificial intelligence" software, DECIDE had again retraced and recapitulated the evolutionary development of ABSEL research.

CONCLUSIONS

The goal for this paper is to review key development stages of ABSEL research and relate the corresponding development of the DECIDE simulation since its inception. It clearly is the case that DECIDE, and its subsequent extensions and applications, has gone through an evolutionary process that is paralleled by the same evolutionary process as ABSEL. Figure 1 shows the key development eras that both DECIDE and ABSEL have gone through. It might be an interesting exercise for other simulation developers to consider if their simulations have gone through evolutionary stages that parallel the stages which ABSEL has gone through. It also might be interesting to contemplate if there are additional key developments that other simulations have gone through. So, although one might not be able to demonstrate, in the strictest sense, that the ontogenetic development has recapitulated the phylogenetic development, this premise has provided a useful framework to view developments in DECIDE, as well as, in ABSEL itself. It is also likely that applying the same framework might be equally informative for other simulations.

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