

# The Development of Internet- and Intranet-enabled, Enterprise-wide Knowledge Bases: The Case of System Dynamics Applications in the United States Air Force, 1975 – 2000

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## **Abstract**

The development of the Internet and related intranets has allowed large enterprises to create valuable knowledge bases containing the results of research (e.g., production process studies for manufacturing firms or marketing studies for computer software companies). The collection of system dynamics applications within and for the United States Air Force between 1975 and 2000 is such a knowledge base. This paper presents a comprehensive survey of the unclassified system dynamics literature relating to applications within the US Air Force between 1975 and 2000, and classifies that literature according to such categories as traditional peer-reviewed publication, traditional publication (non-peer reviewed), internal working papers, internet available documents, and intranet (or restricted) materials. The paper empirically documents how the system dynamics-related knowledge base for the USAF is currently distributed between various sources and how well that knowledge base is referenced and cataloged using available reference tools. Additionally, the paper explores how the recent development of the Internet and associated intranet systems for the USAF has influenced the development, distribution, and cataloging of this knowledge base. The paper concludes by speculating on what proportion of the specific system dynamics literature base may be in the readily catalogued public domain and how the development of electronic access technologies over the past 25 years has affected on that accessibility.

## **Introduction**

It was the intention of this research project to find all that has been written about system dynamics applications within, or about, the United States Air Force. Research nets were cast to try and capture not only peer-reviewed and non-peer-reviewed publications, but all the lesser publications in the public and organizational domains. Many segments of the Air Force practice various strains of system dynamics, so the

challenge arose to try and determine by who, for what, and where these applications were taking place.

In this current technology explosion, with more and more organizations making information accessible via the Internet, the Air Force should be an industry leader in this endeavor. Therefore, an extensive Internet, and Air Force intranet<sup>1</sup> search was conducted to assess the Air Force's bibliographic presence in relation to system dynamics. Although the Air Force, for various motivational reasons, does post an exorbitant amount of information on the Internet, this research also found that not all unclassified information appears on the World Wide Web. In particular, USAF system dynamics literature exists that is not available through the standard bibliographic search mechanisms, even though it is not classified or secured information.

## **Methodology**

The research used standard bibliographic search strategies to look for publications that dealt with the US Air Force and system dynamics. With regard to electronic searches, search terms included “system,” “dynamics,” “air,” and “force” (preferably: “system dynamics” and “air force”) were used when allowed by various search engines in order to maintain concept integrity. It is argued that when considering the research goals of this paper, as a minimum, these terms would need to be important to the documents in question. They were searched in all fields to include: title, keywords, abstracts, and full-text.

Initial research work began with database searches provided electronically by the State University of New York at Albany (SUNYA) Library ([www.albany.edu/library](http://www.albany.edu/library)). Primary search was conducted under “Government Information.” This section is subdivided into two sections, “Databases,” and “Internet Resources.”

Search of “Databases” produced no results. The “Internet Resources” section is subdivided into three sections: “Google Search: Unclesam,”<sup>2</sup> “GovBot,”<sup>3</sup> and “usgovsearch.”<sup>4</sup> Of these resources, a total of 97 hits yielded only 3 documents that appropriately satisfied the comprehensive survey requirements of this paper.

Following these searches, exploration turned toward SUNYA’s extensive electronic journal collection. No finds were made in this sector after an exhaustive search.

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<sup>1</sup> The Air Force “intranet” does not specifically refer to a dedicated “in-house” electronic information network, rather, it refers to various Air Force electronic information repositories which may, or may not, require permissive access. Normally, permissive access is given to military, or Department of Defense members who can demonstrate an information “need to know.”

<sup>2</sup> Google returns results from queries using an automated method that ranks relevant websites based on the link structure of the Internet itself. Google only produces results that match all specified search terms, either in the text of the page or in the link anchors pointing to the page. The Uncle Sam portion is aimed directly at government web sites.

<sup>3</sup> GovBot is a search engine developed by the Center for Intelligent Information Retrieval at the University of Massachusetts. It uses the INQUERY search system. INQUERY is a Bayesian probabilistic retrieval engine. It assigns a rank to each document found for a query and delivers documents in order of that rank.

<sup>4</sup> The usgovsearch uses the Northern Light search engine. Its search engine technology uses natural language processing.

Finally, an extensive search of the SUNYA library electronic “Indexes & Databases” section--a query of the *Proceedings First* and *EBSCO* databases and search features--produced no results. Another inquiry using the WebSPIRS (World Wide Web Silver Platter Information Retrieval Service) produced fifty-six hits of which only two produced noteworthy results.

After exhausting the SUNY Albany bibliographic systems, the search turned to the Military Operations Research Society (MORS). Another far-reaching search produced no results. The same outcome was achieved at the Institute for Operations Research and the Management Sciences (INFORMS): zero results.

An Air Force intranet site was next. The Air University (Maxwell Air Force Base, Montgomery, Alabama) database is a compilation of research papers conducted at five Air Force schools.<sup>5</sup> Five hits produced one satisfactory document.

Other searchable Air Force sites included: The Air Force Academy Library, Air Force Institute of Technology Library, Air Force Research Laboratory Library, Arnold Engineering Development Center, Air Force Modeling and Simulation Agency Resource Repository, Air Force Center for Environmental Excellence, Air Force Logistics Management Agency, Air Force Manpower and Innovation Agency, Air Force Studies and Analyses Agency, and the Military Education and Research Library Network. All of these searches produced practically no purposeful information for this study.

Having exhausted, in effect, all traditional and electronic avenues of searches, this study then turned its focus toward more esoteric means of research – word-of-mouth contacts. Initially, researchers turned toward Professor R. Geoff Coyle of the U.K. who has done extensive system dynamics research in military applications in Europe. It was hoped that a person-to-person network--a snowball sample--could be established from contacts furnished from Dr. Coyle. Three initial contacts produced many more contacts in the United States and in the U.S. Air Force. Additionally, in attempting to build upon more word-of-mouth links, personal contacts were made in the same agencies identified in the previous paragraph.

In the end, nearly 500 communiqués were made via telephone and e-mail to over 100 individuals on three continents. Contacts included those with several agencies within the Air Force, the Rand Corporation, several software and consulting agencies, two operations research societies, an aircraft manufacturing corporation, and other agencies linked to the other Services and the Department of Defense. Results from this exhaustive word-of-mouth search produced a variety of U.S. Air Force related system dynamics applications

Finally, with proper clearances obtained, research was conducted at the Rome, New York, Air Force Research Laboratory. Searches of three Defense Technical Information Center (DTIC) databases--the Defense Research On-Line System, the DTIC Scientific and Technical Documents, and the “Works in Progress” Research Awareness Initiative--resulted in five hits of which only three were usable. Throughout this bibliographic

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<sup>5</sup> The Air Command and Staff College (ACSC), Air War College (AWC), College of Aerospace Doctrine, Research, and Education (CADRE), School of Advanced Airpower Studies (SAAS), and the Air Force Institute of Technology (AFIT).

search other resources surfaced via cross-references obtained from bibliographic entries from each document.

## **Findings**

This project, when initially started, envisioned discovering a plethora of system dynamics applications works within, or closely related to, the U.S. Air Force. Alas, this was not to be. In the final count, only 43 written documents have been discovered for the 25 year period, 1975-2000.

At the Systems Thinking and System Dynamics in National Security, 15-17 May 2000, Washington D.C., Professor George Richardson presented to the conference a system dynamics literature review (Richardson, 2000). His presentation was subdivided into several sections that are replicated here. (See the attached "Resources" section that gives bibliographic citations for each of the 43 documents.) It is interesting to note that although there were 43 different documents, several authors appeared more than once-- T.D. Clark is listed as a first author 6 times, J.E. Bartolomei 3 times. Additionally, 12 of the 36 first authors cited are not listed as having a military affiliation.

Of the 43 citations discovered over a three month process, several categories emerged which best subdivide the spectrum of documents. Overall, the literature is broken down into: environmental modeling, programs and personnel, preparation and readiness, battle simulations and dynamics of war, and other miscellaneous studies.

In the environmental modeling category, 10 citations exist. The literature for this part was all found via the Defense Technical Information Center's (DTIC) intranet services and person-to-person contacts. In the next category, programs and personnel, there were 2 articles on program dynamics, 9 on personnel dynamics, and 2 articles on logistics. Discovery of these documents was through DTIC, traditional sources, and word-of-mouth contacts. In the next category, preparation and readiness, research found 1 article in the area of resource allocation and planning, 1 in engineering and design, 10 in weapon systems acquisition and maintenance, and 2 articles in arms transfers. Information for this section was obtained primarily through DTIC, and also web searches, traditional searches, and personal contacts. In the fourth category, battle simulations and dynamics of war, 3 citations were found via web searches and word-of-mouth. The final category, miscellaneous studies, had 3 articles each found through web-based searches or person-to-person contacts.

## **Discussion**

The 43 bibliographic citations are thus the findings of this study. Since the authors hypothesized that there would be a multitude of system dynamics applications within, or about, the U.S. Air Force, the rather small number of citations was counterintuitive. At the very least this finding lends itself to a discussion about the U.S Air Force and its involvement with system dynamics. Additionally, the finding generates a series of musings about system dynamics literature and its availability to the everyday researcher.

- The U.S. Air Force appears to have a substantial system dynamics effort in progress--many and various studies have occurred or are currently underway.

The authors discovered a variety of system dynamics works conducted by or about the Air Force and its members over the past 25 years. Of the 43 documented cases presented here, there are most likely additional research papers which are undocumented but might be elicited through even more extensive informal contacts. The use of system dynamics applications is no stranger to this Service--it is the documentation of such which has not been that forthcoming.

- There is no overarching, or overseeing organizational initiative to monitor, or guide Air Force system dynamics from a central perspective.

A possible reason for not having a more systematic approach toward documenting Air Force system dynamics applications is organizational in nature. Particularly, senior military levels appear to lack a vision of such applications. This lack of vision is not aggressive condescension, but rather, a lack of knowledge and awareness by senior leaders of system dynamics' benefits and applications.

- Accessible system dynamics research within the U.S. Air Force organization is being conducted by a small number of individuals.

Current practitioners of system dynamics appear to perform their duties almost singularly through their own recognizance. They have strong desires to professionally pursue the discipline, and do so on their own, yet they await organizational change which will foster an environment conducive to concerted effort by many.

- Information sharing is not without barriers.

Both lack of professional incentives and the existence of institutional demands appear to create obstacles to the dissemination of Air Force system dynamics literature. There appears to be no overarching organizational incentive to produce system dynamics literature within the Air Force. Additionally, due to the nature of some system dynamics application topics, there is a tendency not to produce such items in the public Internet structure for reasons of military security. Thus, there may be little to motivate researchers within the military to disseminate their findings to a wider audience, even if security is not an issue. (See Andersen, 1998, for a discussion of similar barriers within the international system dynamics community).

- Air Force authors of system dynamics literature do not use “system dynamics” as a keyword when registering their printed works with various databases.

This is an interesting fact, for many of the 43 citations found via word-of-mouth resources could, however, be backtracked into various databases. In other words, the written material was germane to the topic, yet keyword searches could not produce the

desired results. This stems from poor author self-identification of “system dynamics” being core to the written topic. Proper awareness of such an oversight among the various Air Force authors could easily bring correction to this problem.

- Other Services seem to produce more system dynamics literature.

Qualitative discovery during the research process for this paper suggests that the other Services (Army, Navy, Marines) appear to have, numerically, more citations in the literature than the Air Force. Why is this so? The answer may be in the organizational approach, and “level of interest” fostered by each Service. Future study could unveil and elaborate upon this perceived discrepancy.

- The common literature available to the public can be considered the “tip of the iceberg” with regard to information sharing of system dynamics applications in the Air Force.

In order to best describe this phenomena, refer to Figure 1 which best demonstrates, from the researchers' point of view, how system dynamics application information is laid out in relation to organizational boundaries. As can shown here, the tip of the iceberg represents only that information which could be seen by the researchers using traditional search techniques along with the use of Internet search engines--in other words, those items which could be easily found. However, below the organizational

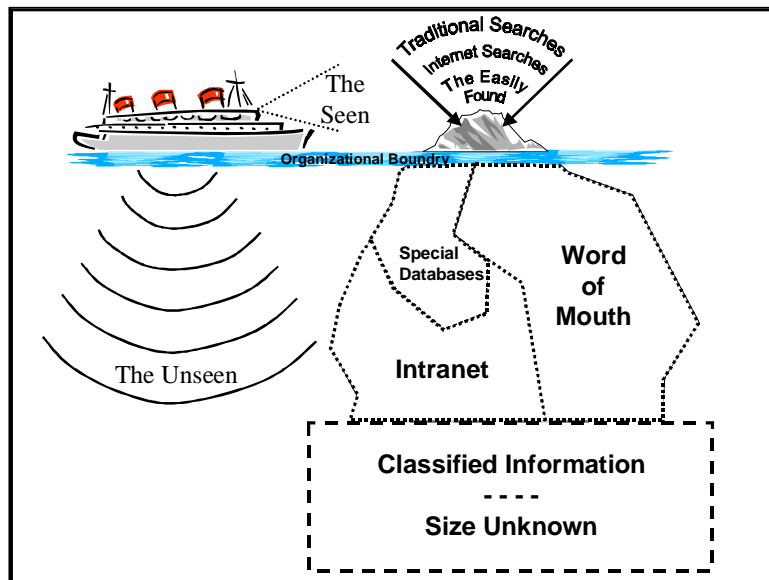


Figure 1

boundary are those items of information which cannot be seen for the average observer. Herein, the researchers had to obtain special permissions to view those items of information located in either special databases, or in Air Force organizational intranets. Important to the success of such research is that one of the authors is an active duty member of the Service. This was also a contributing factor to removing any barriers to information when it came by word-of-mouth contacts. An uniformed individual has a far greater chance at success than the average observer when dealing with intra-organizational contacts and classified information.

## **Recommendations**

It is the position of the researchers that there is more system dynamics application works being done within the U.S. Air Force than the literature reflects. Forty-three literature discoveries over a 25 year period does not exemplify a robust system dynamics corpus on behalf of a large organization such as the U.S. Air Force. Nonetheless, it is worth pondering if this phenomena is descriptive of only the Air Force or if it can be generalized to other large, corporate organizations. The authors have hypothesized that the phenomena is not entirely restricted to the Service agency in question.

Recommendations coming out of this research therefore include the following and are not limited to system dynamics within the Air Force:

1. A parallel study of the research phenomena should be conducted in another government agency as well as in a large corporate organization. For example, it would be worthwhile to determine if such information problems exist in the U.S. Navy or at General Motors.
2. Instill upon system dynamics practitioners that they properly categorize their written works with the use of “system dynamics” in the keywords portion of their listing. This may seem obvious to the un-indoctrinated of the profession, however, it is frequently overlooked by those who actually engage in writing about the discipline.
3. Researchers need to work to overcome institutional barriers which prohibit the free flow of information within their craft. This includes a cultural change needed to overcome the tendency of “not bothering” with Internet information production and web updates. Additionally, dynamic researchers need to push for clearer policies that better define security issues. It is ventured here that much of the written works which have failed to make it to the public domain need not be held back for security reasons. They would be of greater benefit to others via information sharing rather than being suppressed with no major security reason.
4. Organizational leadership must become more acquainted with the benefits of system dynamics. Proper knowledge can only lead to a proper vision of the discipline within an organization. Leadership can foster the necessary involvement required to further the ideas of a select few to the needs of many.

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