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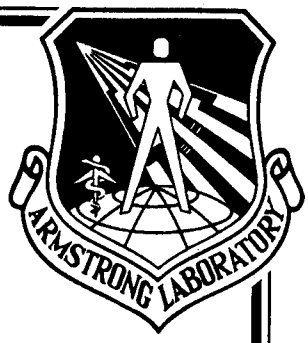

THE GROUP RESEARCH LABORATORY FOR LOGISTICS: DEVELOPMENT AND FIRST USE OF A GROUP SUPPORT SYSTEM FACILITY WITHIN THE AIR FORCE ENVIRONMENT

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The Group Research Laboratory for Logistics (GRLL) was developed as a flexible, realistic research environment that would permit the investigation of the basic utility of Group Support Systems within the military acquisition environment. In this paper, we present the basic design considerations for the GRLL, data on its initial use, and lessons learned in the areas of technology design and employment within the Air Force environment.

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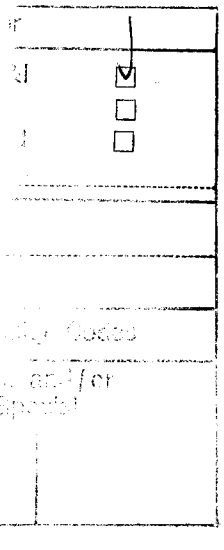

Preface

The GRLL was developed as a flexible, realistic research environment that would permit the investigation of the basic utility of Group Support Systems within the military acquisition environment. In this paper, we present the basic design considerations for the GRLL, data on its initial use, and lessons learned in the areas of technology design and employment within the Air Force environment.

This work supports the Armstrong Laboratory, Logistics Research Division, Acquisition Logistics Branch's (AL/HRGA) ongoing work in the area of developing and demonstrating various integrated tools and techniques to aid in implementing Integrated Product Development (IPD) and support the in-house capability to perform research and development in design decision support, information technology and information integration for weapon system requirements development and product design (work unit number 1710-00-18).

Introduction

Until recently, computers have been used primarily to support individuals working on individual tasks. The availability of new technologies has enabled researchers and system developers to explore the use of networked computers to support teams doing group work. Group support systems (GSS) have been developed to help teams with a variety of tasks, ranging from sharing ideas, organizing alternatives, negotiating for consensus, and voting on options, leading toward the realization of team goals. GSS have been shown to increase the effectiveness and efficiency of teams by supporting and enhancing beneficial group processes, while circumventing or minimizing many of the counter-productive aspects of group work [Heminger 1989, Nunamaker et al. 1989].

Supporting teamwork is of significant interest to many organizations, including the Air Force, because of the central role teams perform in today's organizational life. To explore this area, the Air Force Armstrong Laboratory, Logistics Research Division, (AL/HRG), at Wright-Patterson Air Force Base sponsored the development of the Group Research Laboratory for Logistics (GRLL). We created this facility to conduct research into the applicability of GSS technology to Air Force (AF) teams, to better understand both the design of multi-functional teams and team-enhancing technologies, and to understand more fully the role of human facilitation and the feasibility of employing nonhuman facilitation agents in a GSS environment. In this paper, we present the basic design considerations for the GRLL, data on its initial use, and lessons learned in the areas of technology design and employment.

Organizational problem solving makes extensive use of groups and teams. (Although some researchers distinguish between these terms, differences are not important within the context of our current GSS research.) As with most large organizations today, there are a number of reasons for the extensive use of teams within the Air Force; organizational problems can be very complex, and they may require input of from a variety of experts and group "buy-in" or endorsement of selected solutions. The consideration of these reasons leads to the exploration of teamwork for problem solving.

Most organizations, including the AF, recognize the value of teamwork. For example, Air Force Chief of Staff, General Merrill A. McPeak has said that, "Teams are the key to quality and innovation" [1993]. It is widely accepted that extending computers to support teamwork holds great promise. Even a partial realization of

promised effectiveness and efficiency gains would have great value for organizations that already value teamwork.

Recent technological advances (e.g., those permitting greater connectivity and those improving the human-computer interface), coupled with organizational needs, have stimulated researchers and system developers to explore the use of networked computers to support the work of teams.

The central role of teamwork within the Air Force compels it to seek methods that will improve team productivity. Research that led to the creation of the GRLL was undertaken at Armstrong Laboratory located at Wright-Patterson Air Force Base (WPAFB). This base is also the headquarters for the Air Force Materiel Command (AFMC), one of ten major commands within the AF, with logistics responsibilities throughout the AF. AFMC researches, develops, provides, and supports all AF weapons systems, from cradle to grave, controlling a multi-billion dollar annual acquisition budget.

The GRLL was developed as a flexible, realistic research environment that would permit the investigation of the basic utility of GSS within the military acquisition environment. In this paper, we present the basic design considerations for the GRLL, data on its initial use, and lessons learned in the areas of technology design and employment within the Air Force environment.

Background

While computers are ubiquitous in today's offices, they are typically used to support individual workers performing individual tasks [Stefik et al. 1987]. Yet, studies indicate that office workers spend from 30 to 70 percent of their time in meetings [Panko 1964]. With this much of the office workers' time spent in collaborative work efforts, it would be valuable to be able to bring the power of computers to bear on the needs of the work group. The effort to meet this need has led to research in the area of group support systems (GSS). A GSS is defined as a computer-based system, comprised of a facility, hardware, software, procedures, and facilitation, which is designed to support and augment the efforts of work groups to complete unstructured[1] tasks [Heminger 1989].

GSS research has received much attention in recent years, with many articles appearing in the information systems-related literature. Programs of research have

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[1]Unstructured tasks are those tasks which are non-algorithmic in nature. That is, the tasks do not have a rigorous solution procedure that will produce a specific, correct answer.

been undertaken at the University of Arizona [Dennis et al. 1993, Jessup et al. 1988, Nunamaker et al. 1987; Nunamaker et al. 1988; Nunamaker et al. 1989], the University of Minnesota [DeSanctis 1988; DeSanctis and Dickson 1987; DeSanctis and Gallupe 1985; DeSanctis and Gallupe 1987; Gallupe 1985; Gallupe 1988 et al.; Gallupe et al. 1987], and at other schools [Bui 1987; Bui and Jarke 1986; Hiltz and Turoff 1985; Huber 1981; Huber 1984]. Some of these programs have a distinct technology emphasis while others seek to understand process issues.

However, as noted by Kraemer and King [1988], the field is still not well developed. Most of the empirical reporting has focused on GSS applied to small groups in either experimental or developmental laboratory conditions. Extrapolating the results of experimental group research to real world settings is inherently problematic because of the large number of uncontrollable, interacting variables in real group settings. Kraemer and King suggest that examination of implementations of group decision support systems in operational environments would provide valuable knowledge about "the promises, problems, and challenges involved in this technology."

To date, the focus of GSS has been on the needs of business teams such as strategic planners, product concept developers, and business-problem solving teams. Demonstrated benefits of GSS in these settings include shorter meeting times, more productive meetings, increased participant satisfaction, reduced project completion time, larger solution sets from which to develop possible solutions, opportunities for innovative problem solutions, increased buy-in to the problem solution by participants, and increased awareness of decision making rationale [Heminger 1989, Dennis et. al. 1990]. However, there are many questions about the use of GSS in the military environment. Will the same benefits that have been seen in the business world translate to the military environment? Do differences in the military world require modification of current systems, or will these differences mandate new architectures? Differences in organizational structure between civilian and military organizations may impact the efficacy of GSS. The more structured military chain of command may affect the way that GSS are used and may affect the outcomes produced through GSS-supported activities. Facilitation and forced geographic dispersion of participants may influence the best course of adoption of GSS technology. The GRLL was created to investigate the use of GSS in a specifically military context that includes operational procedures and outcomes, development of GSS standards, and technology diffusion within the military environment.

Decision Room Facilities

A commonly used GSS is usually designed to operate in a decision room environment. Typically, it includes 10 to 24 networked computers that run software designed to assist a group in undertaking basic problem solving processes: gathering ideas, organizing ideas, negotiating, and then making a selection such as with a rank-order voting technique.

One of the earliest computer-supported decision rooms was created in the late 1970s by Gerald Wagner at Execucom [Gibson and Ludl 1988]. This system incorporated a table with eight participant terminals, a lab moderator terminal, and a large front screen, all connected to a Prime 400 computer. The software for the system, called Mindsight™, was designed to facilitate communication, elicit ideas, share information, analyze data quantitatively, and measure group consensus. The system could accommodate both attributed and anonymous comments.

Although the decision room supported by Mindsight™ had most of the features of today's GSS, it was not a successful effort. The project began with high expectations, but over a period of three years, the room fell into disuse and was eventually dismantled. Gibson and Ludl concluded that this effort failed, not because of the technical shortcomings of the system, but largely because of management's insistence that all ideas be attributed (i.e., with the submitter's name attached). They found that users saw attribution as unfair coercion and that users resisted using this version of a GSS. These findings were an early indication of the importance of specific features of a GSS such as anonymity and management influence over meeting process.

The University of Arizona's first GSS facility was created in 1986. This ten-station facility, with networked computers at each station, had a large public screen and linked all components by a local area network (LAN). A human facilitator controlled the software and ran the meeting. Although the impetus for the creation of this room was to support the development of requirements definitions for systems analysts, it was quickly seen to have much wider application. Groups of many kinds, performing many different tasks, could also benefit from using this system.

The creators of this system perceived the system's commercial viability and a commercial spin-off from the university, Ventana Corporation, was created to further develop and market what became known as GroupSystems. This popular system has undergone several upgrades and is currently available as a DOS-based product, GroupSystems V™. A Microsoft Windows™-based version has been developed and is just now being shipped.

IBM supported the early development of GroupSystems. At one time, IBM marketed its own version of Ventana's software under the tradename TeamFocus™. IBM's first GSS facility was created in 1987 at its plant in Owego, New York. Experience with this facility was satisfactory, and over the next few years, several dozen similar facilities were created at other IBM plants around the country, using first, GroupSystems, and later, TeamFocus.

At this time, many operational decision rooms are in existence around the country and are using systems like GroupSystems V. Most of them are in private commercial settings, but a few are installed at military installations, including the Washington Navy Yard in Washington D.C. and Redstone Arsenal in Huntsville, Alabama. However, AF use of this technology has been minimal. A decision room facility was developed at Wright Patterson Air Force Base (WPAFB) to explore the use of this technology in an AF setting.

Development of the Group Research Laboratory for Logistics

Demonstrated effectiveness in a number of commercial settings and the Air Force's interest in improving work undertaken by teams prompted our decision to investigate the use of GSS within the Air Force environment. The Logistics Research Division (AL/HRG) also recognized emergent concurrent engineering process as a shift to group-oriented rather than individually focused design processes. Analysis of empirical research continued to suggest that a business process focus was both a feasible and potentially profitable research domain.

Initially, in the summer of 1991, AL/HRG had little more than a GSS demonstration capability. It consisted of six laptop computers, equipped with Ethernet cards and connected by a Novell NetWare® LAN. One of the laptops with a 120 megabyte hard-drive served as the network server. The first two GSS software systems tested were a demonstration version of VisionQuest™ and a prototype system from Indiana University.

Results from the demonstration facility were positive, so we decided to explore the creation of a larger facility (i.e., the GRLL) that could support larger meetings. This would open up our research to a much larger share of the meetings that take place in the WPAFB community. A group facilitator from the Total Quality office estimates that more than two-thirds of all groups they worked with had six or more members, and a GSS that could support ten participants could support about 90 percent of all their groups. Ten work stations also matches well with many of the other GSS facilities that

have been created in other locations [Wagner et al. 1993], so we decided to create a ten-station facility.

We selected GroupSystems V from Ventana Corporation of Tucson, Arizona, as the GSS software. This commercial grade software supports major functions of goal-oriented group work (e.g., idea generation, idea organization, and decision making). Novell NetWare was used as the LAN software.

For hardware, we selected notebook size computers because of the potential value of portability. However, reasonably priced notebook computer displays at this time were monochrome only and were of unsatisfactory contrast for regular use. Concern was also raised about the usability of the small notebook keyboards. In the interest of usability, we have included external keyboards and color monitors.

To complete the facility, we purchased workstation desks and chairs, adjustable lighting, and improved air conditioning. Workstation computer tables with a 28-inch height (versus 30 inches for a standard desk) were selected to provide optimal access to the keyboard and to allow more room for participants to see each other over the tops of the monitors. For chairs, we selected adjustable, cloth upholstered, swivel armchairs.

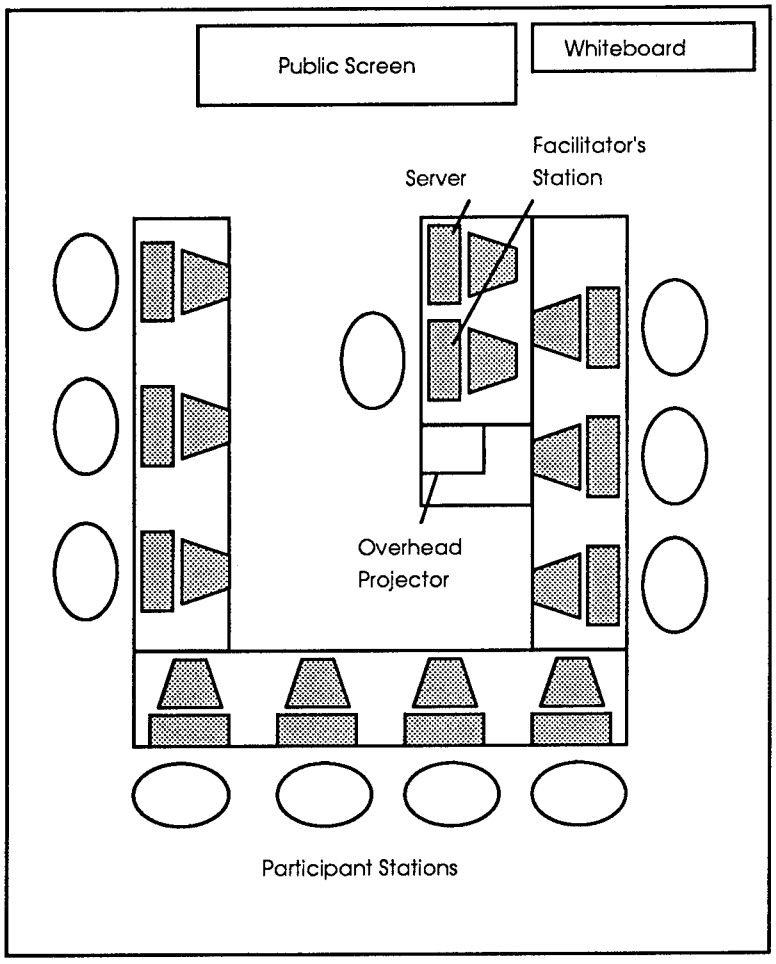

Figure 1. Group Research Laboratory for Logistics

The GRLL, located in Building 434 of WPAFB became fully operational in February of 1993. Like many GSS facilities, the GRLL is a dedicated facility with zoned air conditioning and lighting. It contains desks, networked computers, a large public screen, white boards, and other features that support team meetings (see Figure 1). Raised flooring provides channels for under-floor wiring.

The normal GRLL configuration occupies

approximately 720 square feet of space (30 feet deep by 24 feet wide) within a 1300-square-foot room. A movable back wall allows the GRLL to be expanded for larger groups. In normal configuration, the GRLL supports ten participant stations, but it has been expanded at times to support fifteen. The participant stations are arranged in a "u-shape" with the open end of the "u" facing the facilitator and front screen. The LAN connects the participant stations, server, facilitator's station, and a large public screen.

GRLL Research Program

Research on GSS at AL/HRG will benefit Air Force acquisition teams by providing better tools and methods for accomplishing group work in both face-to-face sessions and sessions that may be distributed in time and place. The research also will explore the factors critical to successful implementation and adoption of GSS within an AF setting. The result of these research thrusts will be the production of recommendations for appropriate tasks, tools, and procedures for more effective and efficient group work.

An important new group process within the Air Force, and throughout the Department of Defense (DoD), is business process reengineering (BPR). It has been codified within DoD by Directive 8120.1, which mandates its use for development of new systems. Within the Air Force, much of the emphasis has focused on advanced physical automation of information, commonly referred to as "paperless acquisition." However, other factors, such as the organization and coordination of group work, may also play an important role in improving organizational processes. A major focus of research within this area is the computerized support of group work, using GSS.

Although commercial GSS have been available for several years, they are not yet well integrated into mainstream use by most organizations. Much of what is known comes from a relatively limited number of operational settings, and from experimental sessions undertaken in laboratories. While there are a number of facilities in private organizations, there are relatively few within the military establishment. The Navy has an operational GSS facility at the Navy Yard in Washington, D.C., and the Army has one at Redstone Arsenal in Huntsville, Alabama, but the Air Force does not yet have an operational facility. In addition, a review of the literature clearly shows that it is difficult to draw meaningful lessons about operational use from experimental settings [Dennis and Gallupe 1993]. Thus, relatively little is known about long-term GSS effectiveness, efficiency, and user acceptance within operational settings. Equally little is known about optimal designs and procedures for using such systems. Therefore, there is a

need for more investigation of operational GSS settings and sessions, particularly within the Air Force environment.

There are a number of areas where GSS applications may be particularly appropriate for the Air Force. Among these are quality improvement programs such as Integrated Weapon System Management (IWSM), Quality Air Force (QAF), and Integration DEFinition (IDEF) modeling of Air Force systems, as well as planning and ad hoc problem solving in general. The common denominator of these areas is the need for appropriately structured, frank discussions among groups working together toward a common goal.

Some of the factors that may be important for these groups include multi-disciplined composition, differing rank, and familiarity of participants with both the nature of group work and the system used to assist them. In each of the areas that may be well served by GSS, there is a need to investigate the use of current GSS, create and test new tools, and design and test new procedures. As GSS technology matures, the factors that promote GSS dissemination and acceptance within the Air Force community will also become important.

The AL/HRG Division research program intends to foster research into these themes as a natural component of re-engineering the acquisition process. Research into coordination and collaboration of Integrated Product Development (IPD) teams will successfully augment current research initiatives in other parts of the AF and DoD. We believe the GRLL research program will provide valuable information that can be used to enhance work within the IPD community and throughout the Air Force.

Initial GRLL Use

The GRLL became operational during February 1993. Since we intended to explore the effects of GSS on real world groups, initial efforts focused on introducing the GRLL to various collaborative groups at WPAFB. Initial publicity of the availability of this service was aided by an article explaining the GRLL in the *Skywrighter*, the WPAFB newspaper. The article generated many inquiries and a number of demonstrations and sessions resulted from it.

While initial use of the GRLL for real world sessions was slow at first, it grew steadily during its first year. We defined a session as a single use of the GRLL if the session duration was one day or less. If the session spanned multiple days, each day of use was counted as a session. One-hundred-seventeen sessions were conducted during the first ten months of use (through November 1993). During the first five months, 59 percent of all GRLL sessions were demonstrations to potential users or

potential champions, those who could influence others to use the facility, while the remaining 41 percent were actual (as opposed to demonstrative or experimental) sessions. During the second five months, 29 percent of nonexperimental sessions were demonstrations, while 71 percent were meetings. In addition, there were 2.4 times as many sessions during the second five month period (see Figure 2).

Experimental sessions comprised those sessions held for the purpose of testing specific research hypotheses, in which the groups undertook various experimental tasks, unrelated to real world sessions. Results of these experiments are reported in other papers on the research program.

Number of sessions in the GRLL - First 10 Months (Feb - Nov 1993)			
	1st 5 months	2nd 5 months	Percent of Total
Demo	20	12	27.3%
Experiment	0	14	12.0%
Pre-planning	0	8	6.8%
Meeting	14	49	53.8%
Total	34	83	117= 100%

Figure 2. Summary of GRLL use

The use pattern of the GRLL over the ten months affirms that there is a substantial market for GRLL services and GRLL research within the AF community. This is further supported by the fact that one of the groups traveled from Scott Air Force Base, Illinois, a distance of about 200 miles, to use it. Many other sessions included members that traveled from other bases to take part in the meetings.

Data were collected from participants using a post-session questionnaire (see Figure 3). These data suggest that GSS support is perceived by the participants as valuable, with 61.3 percent of the users saying that the system helped their process. Similarly, 75.5 percent said that they would choose to use the system again. These findings are in general agreement with findings from other GSS sessions held with real world working groups [Heminger 1989, Dennis et al. 1993].

Seventy-one percent felt that a distributed GSS would add even more value. For many of these people, temporary duty (TDY) excursions to meet with various working groups are a regular occurrence. The cost in time and money expended to attend various meetings can be considerable. If some of the sessions could be held via a distributed GSS, it would provide considerable savings.

An important issue in the use of GSS is the role of facilitation. Although researchers originally hoped to be able to replace human facilitators with a GSS that would supply this role, our experience and observation has shown that, in fact, facilitators are still very important to the GSS process. The data collected here also supports that conclusion, with 80 percent of the participants reporting that the facilitation was very helpful. If these observations hold up during future research, it may have ramifications for the design and use of distributed GSS, where a human facilitator is not easily incorporated into the system.

Post Session Participant Assessment of GRLL Sessions (in %)						
n= 168		strongly disagree	disagree	not sure	agree	strongly agree
1	GSS system helped our process	7.3	11.7	19.7	38.7	22.6
2	GSS system helped us reach our goals	0.6	1.8	17.3	67.3	13.1
3	Would be more valuable if distributed	0.6	3.6	24.4	39.9	31.5
4	Facilitation was very helpful	1.2	7.7	11.3	46.4	33.3
5	GSS has been an obstacle to our process	34.1	49.7	11.9	3.6	0.6
6	I would choose to use the system again	1.7	4.8	17.9	44.6	30.9

Figure 3. Post session questionnaire data

In June 1993, we undertook one of the largest uses of the GRLL to date, a cross-service depot maintenance modeling effort, sponsored by the Joint Logistics System Center (JLSC). The modeling methodology selected for this task was IDEF0. IDEF0 modeling is a process in which the activities of an organization are modeled in terms of their inputs, their processes, and their outputs, as well as capturing controls and mechanisms. In the past, this has been a process involving either individuals or very small teams. The JLSC session was an early attempt to support larger teams doing IDEF modeling.

This process, the largest to be supported in the GRLL to date, involved 30 participants, representing five service components (Air Force, Army, Marines, Naval Air and Naval Sea), four IDEF facilitators from MICAH Systems, Inc., (a management consulting group), and the services of Capt. Kennon Moen and Dr. Alan Heminger from Armstrong Laboratory.

Although the GRLL was only configured with 15 workstations, we accommodated 30 participants by sharing the use of the available keyboards. This sharing was not a major obstacle to successful use of the GRLL for this group. Initially, JLSC arranged to

use the GRLL for one week out of a multi-week process. After the results of the first week, they were sufficiently satisfied to ask to make use of the GRLL on through the rest of the summer and fall for their modeling effort. To date, JLSC has used the GRLL for this process for thirty sessions.

It may be useful to comment on the JLSC modeling exercise because of the extreme complexity of the task. The task itself required asking 30 people with widely differing backgrounds and perspectives to create a common model of the maintenance process for all of the maintenance depots throughout DoD. A maintenance depot is a large factory that handles maintenance and upgrades for a diverse range of products, differing drastically by service, from tanks to airplanes to aircraft carriers. In addition, each service has its own way of doing business in areas such as managing, scheduling, and accounting. In essence, this project was large and complex and involved many people with varied backgrounds and interests.

In contrast, traditional IDEF modeling is a process which has been done in very small groups, with one or two modelers talking to two or three subject matter experts (SMEs) at a time. Individual interviews are then integrated by the modelers and returned to the SMEs for comments and corrections, a time consuming process under the best of conditions. This process is clearly not feasible for such a large group and such a complex task. Therefore, JLSC decided to make use of the GRLL in an attempt to include more input from more people in a shorter period of time. Using the GRLL for this process demonstrated that it can support groups and tasks of this size. However, because IDEF0 modeling is a specific methodology, and because the GroupSystems software supports more generic processes, only part of the modeling process could be supported with the current system. Within those constraints, however, the GRLL was deemed by JLSC, as well as by the Armstrong Lab personnel, to be an effective way to assist large groups in undertaking more rapid development of large, complex IDEF0 models. An assessment by JLSC of the use of the GRLL estimated that the work done in five months time using the GRLL would have taken eighteen months or more the standard way.

Other users of the GRLL have included groups from Air Force Material Command, Air Force Security Assistance Center, Air Mobility Command, Aeronautical Systems Center, and Air Force Institute of Technology. This broad range of users has provided an opportunity to assess the usability and acceptance of this type of group support across a wide spectrum of operational users. User assessment questionnaires given to each user at the completion of each group's work indicated a strong user

acceptance of this type of support for the many tasks that brought the groups to the GRLL.

What Was Learned

The initial use of the GRLL has demonstrated a number of lessons that can be applied to both the continued research effort in the GRLL and to the operational use of a GSS facility. The major findings are described in the following sections.

Broad interest in GSS support. Our experience with requests for use of the GRLL suggests that there appears to be a strong interest in finding ways to improve team meetings in the Air Force. The only advertising done to promote the use of the GRLL was an article that appeared in the June 18, 1993, issue of *Skywrighter.* From that article and from word of mouth, the GRLL has been kept very busy throughout the calendar year, up to the time of this publication.

Ease of learning/using. Across the GSS sessions held in the GRLL, there were no instances of participants unable or unwilling to use the software. This may be related to the fact that 89 percent of users said they were comfortable using computers. Based on observation and experience in the GRLL, the best way to teach people to use the various GSS software modules seems to be to explain a module at the time that the group first uses it. This cuts down on trying to teach a larger number of modules at once, thus reducing cognitive burden. For most modules, participants become proficient with the tool in a matter of a few minutes. The participants' high level of computer comfort probably helps to ease the learning of the system. However, everyone who tried to use the system was successful, irrespective of his/her initial comfort level.

Portability. The computers purchased for use in the GRLL were specifically chosen to be easily portable (they are all either laptop or notebook size). However, we discovered there is more to creating a portable system than movable computers. The state of the art in computers and networking still requires extensive cabling to power and connect the computers. Then, once the hardware has been connected, the software must be loaded and checked for proper configuration. Therefore, moving the system and setting it up in another location can be a time-consuming and laborious job. With improvements in wireless networks and attention paid to custom cabling, portable systems may still be an option for some organizations. However, based on our experience, we do not recommend portable systems at this time.

Variety of possible uses. Although GSS have been used successfully for many different types of groups, the common thread among all of them has been that they are working in a text-based fashion on goal-oriented problems that use the basic processes of idea generation, idea organization, and selection. However, many other types of groups do not fit this model, either because their task is not text-based or because they need to undertake processes that are not supported by the system. For example, while experience here has shown that current GSS can be profitably used with IDEF0 modeling groups, it does so in a limited fashion. While much of the knowledge needed to create an IDEF0 model can be captured in a text-based GSS system, the specific relationships inherent in IDEF0 models cannot be easily captured in a comprehensive way. In addition, IDEF0 models are intended to be displayed graphically, something text-based GSS cannot do.

Importance of pre-meeting planning. Based on the previous experience of our facilitators, we adopted a policy that all sessions would be planned through a formal procedure termed a preplanning meeting, or "pre-meeting." At this pre-meeting, the facilitators would meet with the meeting leader to determine the session goals and to develop an agenda to accomplish that end. This process worked quite well as a way to establish an agenda that could be successfully implemented within the constraints of the GSS mediated session. While we did not run comparisons of sessions without preplanning, we believe that preplanning is an important condition for a successful GSS session. We initially expected that pre-meetings would be one-time events lasting about an hour for each session, but it turned out that quite a few of our sessions required several pre-meetings. Answering such basic questions as the goal of the session, at times, took multiple pre-meetings. Our experience with this process has convinced us that preplanning is essential for most of the sessions that we have facilitated.

Because of this observation, we have tentatively concluded that many people do not routinely think through their meeting processes in terms of goals and processes to achieve those goals. To the extent that this is true, preplanning may provide value to many meetings, whether supported by a GSS or not. It may be that this need for better meeting planning has been present all along but that it has only become visible in the light of planning for GSS use.

Importance of facilitation. A distinction can be made between the structure provided by the GSS and the facilitation of the process provided by a facilitator. The GSS provides a somewhat static, though tailorable structure for group work. This structure is based on a series of logical steps that are intended to lead the group to achieve its goals. Facilitation, on the other hand, relies not so much on a logical structure of the process as it does on the ebb and flow of group interactions throughout the meeting. These two structuring processes, the GSS tools and facilitation, work together to aid the group in attaining its goals. In many of our GSS sessions, the facilitators adjusted the agenda and modified the use of the GSS to respond to opportunities or to adjust to problems that arose. Without proper facilitation, the group might not achieve its goals and would likely be unable to capitalize on opportunities that may arise. Our observation, as well as comments from the participants, leads us to believe that facilitation is an important factor to the successful use of GSS.

Ability to support complex projects with blend of manual and automatic techniques. Although the GSS software that was in use in the GRLL was not designed specifically to support IDEF modeling, it was used effectively as a part of an overall process, which included both manual methods and a stand-alone computer modeling system. We learned that GSS do not have to be the only, or even the primary, vehicles for group interaction for them to provide value to a group endeavor. The key to making effective use of GSS appears to be identifying those processes within the larger session that can be supported and augmented by GSS.

Need for oral as well as computer interaction. We have observed that conversation, as well as computer input, is important to participants of a GSS session. While structured information is entered into the computers for capture, much oral discussion still takes place in a GSS session. It will be important for designers of GSS facilities to keep this need in mind as they design future GSS environments. This will also have ramifications for designers of distributed GSS, where the participants will not always be meeting face-to-face. Additional communications channels may need to be developed to support some type of informal "oral" interactions.

Need for extensions of the system. While the basic processes of gathering information, organizing that information, then making choices about it are well supported by current GSS software, there are specialized needs of some groups that could be better supported by software that is tailored to those needs. An example of

this is the use of GSS for some types of IDEF modeling. There are specialized tasks that take place in an IDEF session that are carried out by the team but are not supported by the current text-based GSS. These tasks include the ability to create complex process structures and the ability to display them graphically.

Potential Future Research Directions

IDEF modeling. DoD Directive 8020.1 mandates that functional modeling will be used to create as-is and to-be models of systems that are to be supported by new information systems. More recently, DoD has stipulated that the method for doing that will be IDEF modeling. However, the current process for implementing IDEF modeling tends to be lengthy and labor-intensive. Work in the GRLL has shown that the IDEF modeling process can be made more effective and efficient with GSS support, but much can be done to tailor this technology for IDEF modeling. Research in this area could provide substantial cost savings and increased value to the modeling process but will require the development of both new techniques for IDEF modeling, as well as the design, development, and testing of new GSS tools that can augment the IDEF modeling process.

Distributed group work. Based on feedback from many GRLL users , we believe there is a need for, and an interest in using, a distributed GSS. Although a few of the major GSS systems are beginning to explore this need, much is still to be learned. There is a real need for continued research to investigate the best ways to support teams that are working as a group, even though some of their "meetings" may involve virtual connections in which the members may be participating from different locations at different times. Downsizing and IWSM operations make distributed meetings more desirable than ever before. Advances in GSS supporting technologies (e.g., networking and communications, multi-media presentation) further extend the feasibility of creating effective distributed GSS.

Automation of facilitation. The movement toward distributed GSS will necessitate that new ways be developed to provide needed meeting facilitation. By its very nature, a distributed session has participants meeting at different times and/or places, using the computer network to provide the organization and structure of the "meeting." Therefore, it will not be possible to have a facilitator stand up in front of the group to help with group interactions and to help move the agenda along. Not only may people not be meeting at the same place, but they also may not even be meeting at the same

time. This will necessitate that the meeting will last longer than a comparable same time and place meeting. It is conceivable that such a virtual meeting may take place across several days, so providing "live" facilitation becomes an issue. Without a live facilitator, any facilitative process may have to come from the system itself. We do not yet know the important features of this process, nor the method of implementing them in a distributed GSS.

Inclusion of expert system support. Although each meeting is unique, similarities among meetings, such as stringing together sub-processes to reach the group goal and the sequencing of those steps to get the best results, exist as well. Which steps to take, in what order, and how to map those steps to the various automated and manual support tools is largely a matter of heuristic knowledge. A group may be able to reach its goals in many different ways, but some will likely be more effective or efficient than others. Thus, when planning a meeting, an expert's rules of thumb can be very helpful. This type of knowledge can be captured in an expert system and can be made widely available to support GSS processes.

Summary

The GRLL has been successfully designed, built, and implemented for the study of the use of computerized support for problem-solving groups. Initial use has supported our belief that many types of AF groups could benefit from the support provided by GSS technology. Increasing use of the GRLL by repeat, as well as new, customers, suggests that there is a real need for the type of support provided by this facility. The use of the facility to date has provided much insight into the specifics of AF use of GSS technology and has revealed a number of potentially fruitful areas of interest for future research. Two of the most promising areas are the extension of GSS support to distributed meetings and the extension of GSS support to other types of structured meeting processes such as IDEF modeling.

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Acronyms

AF	Air Force
AFMC	Air Force Material Command
AL/HRG	Armstrong Laboratory, Logistics Research Division
BPR	Business Process Re-engineering
DoD	Department of Defense
GSS	Group Support System
GRLL	Group Research Laboratory for Logistics
JLSC	Joint Logistics System Center
IDEF	Integration Definition
IPD	Integrated Product Development
IWSM	Integrated Weapon System Management
LAN	Local-Area Network
QAF	Quality Air Force
SME	Subject Matter Expert
TDY	Temporary Duty
WPAFB	Wright-Patterson Air Force Base