A Case Study of General Electric's Multimedia Training Systems

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General Electric Aerospace, one of 15 corporate divisions, implemented a series of multimedia training systems in response to the need for employee awareness and understanding of mission-critical compliance requirements for dealing with the US Government. Although employees were satisfied with the traditional seminar approach to training, it was recognized that there was a need to deliver information better in order to increase retention, promote better use of information, and foster the development of more capable employees. In the interest of keeping training refreshed, new ways to deliver information were sought. This case discusses the initiation of the multimedia systems, the processes and considerations for developing and maintaining such systems, and GE's secrets for success in the on-going application of multimedia technology to training.

General Electric (GE) Aerospace of King of Prussia, PA, one of 15 corporate divisions, is one of the top five contractors for the United States Government, with $4-5 billion in sales. As a major Government contractor with 30,000 employees, compliance with laws, regulations, and contractual specifications is a primary concern in business dealings with the Government. Faced with the specter of multimillion dollar fines for noncompliance, delivery and dissemination of compliance requirements is regarded with utmost importance. Responsibility for compliance training for all 270,000 employees within the 15 corporate divisions, is held by the Finance & Information Technology Department and administered through the Compliance Training Center of the Aerospace division in King of Prussia, PA.

In 1985, a more formalized, structured approach to internal training on how to transact business with the US Government was initiated. This approach entailed the use of a series of standard seminars, one for each of 19 modules of the compliance training curriculum, with topics ranging from "Truth in Negotiations" to "New Employee Orientation" and "Kickbacks & "Gratuities." The seminars were administered with a corporate trainer communicating compliance issues, supported by a slide presentation and reinforced through written materials distributed to participants in notebook form.

The content and materials for the seminars were developed with the input of a subject-area expert, an employee whose area of responsibility encompassed the particular compliance module. Five of the 19 seminars were first developed and internal corporate trainers were themselves trained to deliver the first five. The schedule

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ANALYSIS

Step 1: Application Identification
- Define the application
- Determine multimedia needs

DESIGN

Step 2: Design Concept
- Determine overall message, specific points, and target population
- Walkthrough of major sequences

Step 3: Design Content
- Detail application specifications

Step 4: Scriptwriting
- Write the dialogue and detail elements of the sequences

Step 5: Graphic Design
- Design system functionality
- Design set and props

Step 6: Production
- Produce the video and other appropriate media

Step 7: Video Edit
- Prepare the rough and final cuts

Step 8: Authoring
- Integrate sequences into a production

IMPLEMENTATION

Step 9: Installation
- Install and test the system
- On-going maintenance

Table 1: The Multimedia System Development Process

for seminars was formulated with the determination of who should attend which seminars dependent on the employee's area of responsibility.

Although seminar participants were satisfied with the training sessions, it was recognized that there was a need to deliver information better in order to increase retention, promote better use of information, and foster the development of more capable employees. In the interest of keeping training refreshed, new ways to deliver information were sought.

Investigating Multimedia Technology

In December 1989, the Vice President of Finance & Information Technology, Robert W. Tieken, requested the Manager of Operations and Training, John Townsend, to look into applying multimedia technology to compliance training. John Townsend, with the MIS Department serving as consultants, investigated the state of multimedia technology in the marketplace. Multimedia technology incorporates a combination of computer hardware, software, and other devices, such as a video monitor, optical disc system, or stereo system, to produce a multi-sensory presentation. This combination of technology provides a powerful interactive interface enabling an area of knowledge to be more fully communicated. In addition to the traditional text and graphics-based interface, the user is able to selectively see, with pictures, full-motion video, or animation; and hear, with stereo sound, voice recordings, or music, information and explanations which are difficult to conceptualize from mere text alone (Sipior and Garrity, 1991).

Presentations with a mix of audio and visual accompaniments have been found to be advantageous. 3M Company sponsored two studies, undertaken by Wharton's Applied Research Center and the University of Minnesota's Management Information System Research Center, to examine the impact of presentations supported by computer-generated visuals (Johnson, 1989). Both studies found visuals do indeed increase the effectiveness of presentations. When visuals are added, retention increases by about 10 percent; persuasiveness by 43 percent. Federal Express compared interactive-video instruction with classroom training (Yakal, 1989). Although no significant difference was found between the two groups in terms of post-training test scores, the time devoted to interactive video instruction was about 60 percent less. Shell Oil Company also experienced a 60 percent reduction in the hours spent in training, compared to the same material presented in a traditional classroom setting (Zemke, 1991). Another study, by General Telephone of California (GTE) also attests to the advantages of the interactive mix of mediums (IBM, 1989). Relying on the results reported by such studies, GE recognized an opportunity to attain positive outcomes in terms of subject mastery and retention as well as effective use of employees' time.

By April 1990, multimedia had been sufficiently investigated in terms of the state of the technology, its applicability to compliance training, and the potential benefits it could afford. Two courseware developers, Midi, Inc., an IBM Business Partner based in Princeton, NJ, and Authorware, an Apple-based developer, were identified for their superior reputations as multimedia developers. Each was requested to develop, within a ten-week timeframe, a prototype interactive multimedia training system, based on materials supplied from one of the five already-developed seminars, to be demonstrated at GE's Corporate headquarters in Fairfield, CT.

The Prototype Multimedia Training Systems

Midi indicated that ten weeks was not sufficient to complete a prototype of the entire training module. Instead, they offered to demonstrate the full power and capabilities of multimedia technology by developing about one-third of the module. Authorware however, did not express any concern in developing the prototype within the ten-week timeframe.

A one-day demonstration was scheduled for each of the two developers. Midi was able to show the full capabilities of an interactive video-based presentation. Authorware on the other hand, presented primarily text and graphics supported by video. This demonstration was further afflicted by equipment difficulties.

On the basis of the capabilities demonstrated, Robert Tieken made the decision to utilize the services of Midi as the courseware developer, with the intention of subcontracting the development of the first two of the 19 modules of the compliance curriculum in an analog-based full-motion video format. The Compliance Training Center, a centralized department for the delivery and maintenance of information on compliance issues, was equipped with 125 IBM Personal System/2 Model 70s, now increased to 159. Each is configured with IBM's M-Motion Video Adapter/A, IBM 8515 monitor with an Elographics touch screen, a Pioneer videodisc player, an IBM CD-ROM drive, and an amplifier and head set. Additionally, a small number are dispersed throughout the organization. These workstations provide a powerful delivery platform, with the necessary flexibility to accommodate individual learning styles and rates, in completing the compliance training modules.

Recognizing that a high-quality, effective, and efficient training program could be developed through the video-based format, a plan appropriation request was approved in the amount of $4 million to develop all 19 modules. No formal cost/benefit analysis was performed because the risk of noncompliance is the possible suspension of business dealings with the US Government. The goal of this plan was the development of the highest quality, most effective and efficient compliance training program using multimedia technology. Compliance with Government regulations by employees at all levels throughout the organization is mission-critical since GE Aerospace is almost entirely dependent on Government contracts. From the onset, the project was solidly supported by senior management.

The Multimedia System Development Process

The multimedia system development process followed by GE is comprised of 9 distinct steps and can be classified according to the three major phases of the traditional system development life cycle, as shown in Table 1. For each of the 19 modules, John Townsend served as Project Manager of the technical team, comprised of an internal subject area expert(s) and other GE personnel, including Kathy Lintin, a training specialist in compliance, as well as outside consultants from Midi. The development process is approximately 30-weeks in

duration and can be economized into 33 weeks for the development of two related training modules.

Application Identification

In the first step, the topic for the application module is identified and defined. The determination of which of the 19 modules of the compliance curriculum would be developed into multimedia systems first was made on the basis of those for which seminar materials had already been completed. This enabled the initial development efforts to be focused on technological production rather than content preparation.

A number of criteria were then applied to asses whether the application identified was indeed appropriate for delivery via multimedia. First and foremost, the topic had to be of a high priority; one with mission-critical significance for the division. This contrasts with the alternative approach for first-time multimedia systems, wherein the application topic is selected for its high entertainment appeal, focusing attention on the capabilities afforded by the technology, with little regard to content value for the organization. In the long run however, this may cause enthusiasm for multimedia technology to wane as the novelty of the technology subsides. The capabilities of the technology should be utilized to advantage by applying it to subject matter which is conceptually complex; wherein traditional text and graphics are not sufficient to easily and adequately describe elements of the topic area. Communication of the subject should be facilitated by the presentation of full-motion video sequences or scenarios. Thus, the need to manipulate a trainee's exposure to certain elements of the subject area due to factors such as dangerous conditions, which can effectively be simulated; long time durations, which can be compressed while retaining full informative value; or geographical distances, which can be overcome through recorded video or telecommunication lines, all offer opportunities for effectual applications. Finally, due to maintenance considerations for integrated media, the content of the subject should be relatively static over time. This first step is addressed entirely by internal GE personnel; after which Midi is notified so they can prepare for the impending development effort.

Design Concept

To set the direction for the module, a preliminary design meeting is called to determine the overall message to be conveyed, the specific points to be included, and the target population to be reached. The general design of the training module is documented as a verbal overview of about 10 pages in length. This walkthrough is further expanded to include an identification of the objectives; a description of the story line, themes, and characters; and an outline of the major sequences with a brief description of their content. The next 3 steps, design content, scriptwriting, and graphic design are all interdependent and are thus addressed concurrently.

Design Context

The design content expands upon the design concept by detailing the application specifications. Any internal subject materials available, including manuals, cassette tapes, slides, or view graphs, are compiled. A technical team, comprised of GE's subject area expert(s) working in conjunction with Midi, reviews the available references to prepare the detailed design specifications. This entails a number of considerations for designing the system and how it will function, including media selection, user motivation, system interaction, learning strategies, and user evaluation (Bergman and Moore, 1990). Each of these considerations are addressed in the following sections.

Media Selection. The first design consideration, media selection, is dependent upon the characteristics of the particular subject area. Full-motion video, still pictures, animation, graphics, and text screens are all effective means of visual communication; music, sound effects, and voice for audio communication. One, or a combination of media, may be preferable, but tradeoffs must be made. For example, full-motion video may be more appropriate to achieve a greater degree of realism when combined with sound effects, to set a mood when combined with music, or to explain how to perform a conceptually difficult task when combined with voice. Tradeoffs must be made in instances where, for example, the dangerous nature of the subject matter forces the use of animation, while sacrificing realism. Ultimately, however, the decision from among these will depend primarily upon the informative value of the presentation and resource considerations.

Motivational Techniques. Motivational techniques, the second design consideration, serve to keep the system user interested and involved. One or a combination of techniques to consider include (1) vicarious participation, a realistic scenario wherein the user is prompted to participate; (2) role models, depiction of desired behaviors which users are encouraged to emu-

late; (3) reward, a presentation which promotes a sense of user satisfaction; (4) challenge, a game-like situation which invites the user to respond; and (5) curiosity, a presentation which impels the user to continue. The particular technique selected should make the user *want* to continue to interact with the training module.

Interactive Strategies. Interactive strategies, the third consideration, encourage the user to be actively involved and participate with the system. Interactivity may be encouraged through inclusion of a number of system features including (1) simulation, a realistic presentation to which the user responds as if he were actually in the situation; (2) direction, user choices and responses guide the path through the system; (3) input/feedback, user inputs result in system responses; (4) selection, the user chooses from menu options; (5) pacing, the user controls system speed; and (6) viewing control, the user controls presentation interruption, continuation, repetition, and redirection. The use of one or more of these techniques can increase the sophistication of the programming required to develop the system, but undoubtedly has a positive effect on user satisfaction with the system.

Learning Strategies. The fourth consideration, learning, refers to the attainment of comprehension or skill by gaining knowledge. User learning may be promoted by the inclusion of (1) alternate media, presentation of the same information in more than one way; (2) progress validation, checkpoints in the form of voluntary quizzes providing the user with a sense of accomplishment; (3) progress positioning, a mechanism through which the user ascertains progress made thus far and what material remains; (4) experience recognition, assessment of user's subject knowledge to determine start point or presentation alternatives for novice vs. intermediate levels; and (5) user control, degree of presentation control for review, repeat, scan, interrupt, or access of additional material. The decision to incorporate one or more of these techniques into the training module may serve to enhance the learning experience for the user and thus lead to greater mastery of the subject area.

User Evaluation. Finally, the last consideration in design specification is user evaluation. This can serve to assess what portion of the system has been viewed by the employee or whether the employee has gained an acceptable level of subject mastery. The facilities which could be designed into the system to evaluate the user may be obtrusive or unobtrusive. Obtrusive mechanisms could be in the form of questions to assess user learning. The questions could be voluntary or required, single or multiple in number, or reinforcive by providing automatic feedback or on-demand feedback. Unobtru-

Level I:
- The least interactively active
- Presentation is abstract (i.e., lacks graphics, provides few examples, etc.)
- Feedback only indicates answers are right or wrong with few practice opportunities
- Cannot adapt to the user's learning pace or branch to different topics

Level II:
- More relevance to job tasks, but limited in content and design
- Examples and practice opportunities are more frequent, but graphics are superfluous to the learning design
- Feedback is still limited
- Some control over topic selection, but modification of exercises or tests is not possible

Level III:
- Significant improvements in terms of lesson selection control, effective visuals, both positive and negative examples, pretests and mastery tests, etc.
- Frequent and relevant practice opportunities
- Some simulation exercises
- Accommodates user's learning style, rate, and needs by allowing choice of instructional components

Level IV:
- Full-scale simulation integrated into instruction
- Users are able to practice job elements through simulated sessions, without risking negative consequences in the "real-world"

Level V:
- Simulation of actual job conditions is enhanced with the application of artificial intelligence to observe, guide, and coach users, and then modify instruction accordingly
- Adapts to the user's cognitive style
- Critiques the user's reasoning by comparing it to that of an expert and offers help for improvement

Table 2: Levels of Multimedia Training Systems

sive user evaluation may be achieved through automatic tracking wherein usage characteristics such as what applications were utilized by whom, what components of an application were completed by a user, or session duration are recorded by the system. A determination must be made concerning which modules require the evaluation of employee training, what type of assessment is appropriate for each module, and whether feedback should be provided.

Levels of Multimedia Training Systems. Multimedia training systems have been classified according to five levels (Filipczak, 1989), characterized in Table 2. Each level provides progressively advanced capabilities, features, and options. Level one is the least advanced and level five is the most advanced of the levels. The more advanced levels are not always preferable. Selection of system capabilities, features, and options is dependent on the area of application as well as the characteristics of communicating knowledge about that particular area. Thus, the appropriate level for each application should be determined on the basis of what works best to support and facilitate communication of that particular area.

Using Filipczak's classification, GE's systems may be classified as Level IV. The user is able to view and participate in the presentation. For example, a user may interact with individuals present in a simulated meeting. Comments are directed toward the user, questions are asked of the user with the user's response guiding the progression of the meeting, and finally the user may himself pose questions of others present in the meeting.

The design content is completed within about a 3 week period. A final Design Meeting brings together the technical team to discuss any final suggestions or concerns before the script is written.

Scriptwriting

Scriptwriting incorporates the detailed design specifications decided upon in formulating the design content. The major sequences described in the walkthrough drafted in step 2 are expanded upon by determining dialogue and dialogue characteristics such as emphasis, intonation, and pauses; actors, their characteristics, roles, and interactions; and settings, props, and locations. Midi provides the scriptwriter who works closely with John Townsend and the technical team to make the presentation natural, understandable, comprehensive, and as realistic as possible to be believable and convincing. Midi's scriptwriter completes the script in about 3 weeks. It is then reviewed internally by GE and sent back to the scriptwriter for revisions. The script serves as the major form of design documentation and therefore must be revised repeatedly to be sure all details have been considered and planned correctly. This refinement continues for about 12 weeks as the script advances through a series of drafts, until everyone is completely satisfied.

Midi also provides support for both casting and location determination. The talent selected is a major concern since these individuals have high visibility and are oftentimes the focus of the module. The look, sound, and personality of the talent are particularly critical factors influencing reactions to the module and thus deserve careful consideration. In an effort to increase identifiability with video sequences, John Townsend recognized that users' responses to the training module could be influenced in a positive manner by using familiar faces and surroundings. Thus, GE employees and facilities played their parts as extras and settings in many of the sequences.

Graphic Design

Graphic design encompasses graphical elements for both the functionality of the system itself as well as the realism of the set and props. Interaction with the system is an important determinant of user satisfaction with the training module. The objective for the functionality of the system is to make the user interface as easy to use and as seamless as possible. This is achieved by including elements such as menus with alternative choices, graphical representations such as charts and graphs, text-based screens, and special effects such as split-screens and fade in/out. The design of these elements should be done with a consideration of users who are averse to hands-on usage. Alternatives to keyboard interaction are preferable to allow the user to focus on completing the training module, rather than on the computer technology, in system interaction.

The objective for the design of the set and props is to achieve a degree of realism which results in experiential learning. For this to be achieved, the user must personally relate to the situation and environment as well as identify with the actors as they interact with the environment. The user must not only regard what is shown as familiar, but consider the appearance to be realistic.

Production

In production, step 6, the documentation devel-

Title	Role
Producer	The manager of the overall production
Director	Manages the production team during the shooting of video takes
Video engineer	Monitors recording of visuals to maintain quality in focus, distance, and exposure
Audio engineer	Monitors recording of audios to insure clarity and volume consistency
Grip	Sets-up lighting and makes adjustments as necessary
Gaffer	Constructs sets and props and manipulates them as necessary
Camera personnel	Frame and focus shots
Casting agent	Identifies talent
Talent	Act in or narrate the video and audio sequences
Costume & Makeup	Prepare appearance of actors in accordance with the effect to be achieved

Table 3: Roles in the Production Team

oped for the training module is translated into video, and other media appropriate to the application. Midi provides the production team, comprised of the producer, director, video engineer, audio engineer, grip, gaffer, camera personnel, casting agent, talent, and makeup & costume artist. These roles are defined in Table 3. John Townsend works together with this team to organize and shoot the video production.

Having arranged scheduling for the necessary personnel and facilities, the production team and a GE representative arrive on location to shoot the video sequences. The production team is responsible for setting up the necessary set and equipment on location. A rehearsal precedes the recording of all scenes. Attention to detail is necessary to successfully portray all elements called for in the script.

Recording of scenes may be done several times and continues for about a week until the producer, director, and the GE representative are all satisfied with the takes. It is necessary that the objectives of the training module are met, the content is accurate, actors are natural and believable, the set looks realistic, and the technical aspects such as lighting and picture framing are adjusted correctly. Variations on the same scene are also shot in anticipation of future updates to the content of the subject area. These changes are recorded with the module on laserdisc. Such foresight can enable alternative versions of the same training module to exist and thereby preclude the need for costly video productions for relatively minor changes in content which may occur in the future. All changes however, cannot be anticipated in advance and thus may require additional video shoots.

Video Edit

Editing involves selecting the desired video sequences and combining them into the video presentation. This process requires the skill of creative professional editors, supplied by Midi, to ensure a quality presentation is achieved. GE personnel are present throughout this process to offer perspective and suggestions so that the video production meets the objectives of the application.

A series of rough cuts are first made in an effort to get a feel for the order and fit of the sequences, the flow between them, and the interpretation and comprehensibility of the overall presentation. The audio accompaniments are addressed to rectify any imperfections in acoustics and to mix various audio sources such as voice, sounds, and music into single or multiple tracks of the master video as required. The final cut, finished in about a week, is reviewed by GE personnel for acceptance before the video tape is replicated on laserdisc.

Authoring

Authoring entails the merging of the various media elements with the logic of the application to create the pilot version, which is further refined until it ultimately becomes the final version. An integrated set of software, referred to as an authoring system, manages the configuration of components which capture, enter, store, retrieve, edit, and manipulate both the audio and visual elements. This set of software tools supports

program code development, program testing, and program revisions and refinements (Veljkov, 1990).

Program code development requires the author to integrate design graphics at appropriate points to enhance presentation transitions, communicative value, and ease of system use. The program code, which takes about 4 weeks to complete, synchronizes all of the media elements developed separately, and perhaps stored on diverse media such as laserdisc, CD-ROM, or various magnetic media, into an integrated, customized presentation. The program code developed must be tested, debugged, and revised, which continues for about 2 weeks. All possible logical paths users could follow in system use must be tested for errors, such as infinite loops or dead ends. The pilot version is then reviewed by GE personnel to identify any revisions or refinements which may be necessary. Two weeks later, the suggested changes are made and the final version is ready to be installed.

Installation

General awareness of the impending arrival of multimedia training systems in the Fall of 1990 occurred via informal word-of-mouth communication. The first four systems were installed and ready for use by October 1990. Upon installation, 2-3 weeks are devoted to testing the system through a pilot run to get reactions from about 30-40 users before full-scale use is available to all employees. A critique sheet, wherein the content of the training module is the focus, is completed by those participating in the pilot run. The results of this critique determine whether the application will be made available for use by all employees. Feedback on the use of the training modules is continually collected to monitor acceptance of the systems by employees.

Changes in content which occur after installation are handled in two ways, depending on whether they are anticipated or unanticipated. Changes which are unforeseen, resulting from the system test or from updates to the content of the subject area, are developed in text and graphic form and are stored on CD-ROM. Revisions to the program code enable such changes to be seamlessly integrated into the presentation as necessary. This flexibility saves considerable time and expense associated with the alternative, which would be to remake the module. Portability of the module however, is affected since the entire module is not contained on one laserdisc.

Anticipated changes in subject area, on the other hand, were planned for and addressed throughout the development process. Video sequences and other media forms were produced and stored with the module on laserdisc. Again, revisions to the program code allow for the module to be easily modified; substituting the updated sequences for outdated sequences, when and if the need arises. This approach is preferable since it reduces the time and expense devoted to maintenance, but obviously cannot be done in all instances.

Department managers are made aware of the introduction of a multimedia training module through a memo which identifies, in matrix form, who in the department is required to take the module and by what date. All modules are available for viewing by anyone who has the time and interest, serving as an effective means of disseminating information throughout the organization.

To utilize the Compliance Training Center, an employee simply schedules a time, convenient to his own personal schedule. Cancellations or late arrivals are not disruptive to others since completing a module is an individual experience. Upon arrival, the Compliance Training Center Manager, Susan Crowther, is available should users need assistance in initiating their training session. The user first selects the particular module to be viewed. The laserdisc for that module is inserted into the laserdisc drive. After pressing the "start" button, the fully supportive, user-friendly main screen appears. Navigation through the system by users is achieved through a touch screen interface which manages screen activity.

A record of which employees completed what modules is kept. To insure users have attained mastery, a test is presented. A minimum score must be achieved in order for the employee to receive credit. As mentioned, any employee may view any module he chooses, however certain modules are required of selected employees and in these cases, mastery must be achieved.

Secrets of Success

An entire series of training modules provides both continuity and cost-effectiveness to the application of multimedia. Rather than devote the necessary investment to compliance training alone, it was recognized that the multimedia platform could serve as the vehicle for the range of Operational Training needs as a whole.

At the onset, GE had set out to develop 19 multimedia training modules, one for each of the 19 areas of compliance training. With a vision toward the future, John Townsend had the foresight to recognize

that continued use of the technology could be promoted by applying it to additional areas. Shortly after the first four modules were installed in October of 1990, a meeting devoted to cultural diversity issues was held. As the meeting progressed, John Townsend realized this area was ideal for the application of multimedia. This led to the development of an Operational Training agenda, which emerged to include four areas:

(1) Compliance Issues,
(2) Cultural Diversity,
(3) Environmental, Health, and Safety issues, an
(4) Cash Flow/Cash Management.

The multimedia training systems for the first area have been completed, systems for the second and third areas have been started, and the last area has received approval.

Each of the four areas on the Operational Training agenda is regarded as mission-critical to the operations of GE Aerospace. Thus, each module enjoys the all-important corporate sponsorship and is viewed as an excellent long-term investment because of the crucial business need it addresses. Robert Tieken, the Vice President of Finance & Information Technology, is the champion of this highly visible project, overseeing the planning and funding of each module, which has a baseline cost of $75,000 and may run as high as $135,000.

The investment seems to be paying off. User feed-back has shown elements of the training modules retain interest in and satisfaction with utilization of the Compliance Training Center. The modules grasp the attention of users and present a variety of stimulation to reinforce learning. Experience-based scenarios, incorporating familiar language, people, places, and things with which users can personally relate, maintain the credibility of the messages communicated. The vast majority of feed-back from the 150,000 training sessions completed in the last 18 months ranked the session as great or outstanding on a 5-point Likert scale in terms of how successful the training session was regarded to be.

The Future of Multimedia Training Systems

The future of multimedia training systems at GE promises synergistic leveraging, as other corporate divisions have taken an interest in using them. With 270,000 employees to train corporate-wide, the benefits of time and cost reductions, coupled with the increased ability to disseminate information and educate the entire corporate-body, point to a promising future.

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