"Although we often hear that data speak for themselves, their voices can be soft and sly."

—Frederick Mosteller, Stephen E. Fienberg, and Robert E.R. Rourke, *Beginning Statistics with Data Analysis*, 1983

5

Production, Presentation, and Dissemination

Production, presentation, and dissemination of results are often the most time-consuming part of analysis. Too often, technologists overlook this step in the analytical process, but it is the only part of the process that is visible to the consumers of analysis. In emergency situations or in day-to-day activities, technology could make a large improvement in this part of analysis. Our goal is to bring creative research and development (R&D) efforts to bear so we can greatly reduce the time it takes for analytical results to be shared with their audiences, while dramatically improving the effectiveness of this communication.

Introduction

According to the *American Heritage Dictionary of the English Language* [Pickett, 2000], *production* is "the creation of value or wealth by producing goods and services" or, simply, "the act or process of producing." *Presentation* is "something that is set forth for an audience" or "the process of offering for consideration or display." *Dissemination* is "the spreading or scattering widely, as in sowing seed."

In the visual analytics context, production is the creation of materials that summarize the results of an analytical effort. Presentation is the packaging of those materials in a way that helps an audience understand the analytical results in context and using terms that are meaningful to them. Dissemination is the process of sharing that information with the intended audience.

The goal of production, presentation, and dissemination is to convey analytical results in meaningful ways to a wide variety of audiences, including peers, decision makers, and first responders. In addition, communication with the public plays an important part in homeland security. Although members of the public are not direct consumers of analysis, our goal is to facilitate effective communication of relevant analytical results to the public wherever possible. The highly successful AMBER Alert program for engaging the public in finding missing children is a demonstration of the dissemination of information to a broad public audience for their action. This program is a model case for an all-alert system whereby information can be provided

to the public and people can, in turn, provide critical information when appropriate. Communication of the alert message to a broad audience requires a methodology and supporting technology much like what is being discussed here for communication among government team members.

Vision for the Future

Our vision is to integrate production, presentation, and dissemination seamlessly with visualization and analysis, computation, and data acquisition. Access to shared knowledge will be managed automatically to ensure security, privacy, and relevancy to the consumer. This knowledge will be dynamic. The consumer can add knowledge in response to the analytic results or requests for specific data. The analysts also will constantly modify the knowledge as data arrive and are interpreted in context, achieving a more accurate understanding. The visual analytics system itself will detect changes in data already analyzed and show the effect of these changes on the analytical logic used. Analysts may be engaged in collaboration, and relevant telephone or offline conversations should be captured as feasible. Interdisciplinary analysis will be fully supported by the tools, and these tools will be fault-tolerant and capable of operating under hazardous conditions.

In an emergency, we envision the analysts as enablers of complex communications that are appropriate, persuasive, and productive of immediate results. The analyst is adept at assessing data, while the audience for the assessment may not be. The presentation of analytic results needs to be clear and succinct, and it must take place as soon as possible after the analyst reaches a conclusion. To achieve this, we must equip the analyst to easily create displays that reveal what is going on, both in day-to-day analytical activity and in the heat of an emergency.

Tools will allow analytic reasoning, note-taking, production, presentation, and dissemination to occur simultaneously. Even for long-range analysis to support planning or policymaking, it is important to provide the analyst with the capability to build product during the course of the analysis with reasonable ease and be able to share the visualizations and associated analytical reasoning that led to the resulting conclusions. These tools will provide both rhetorical and graphic design support to help avoid potential misuses of presentation software [Tufte, 2003] that would obscure the message. Furthermore, these multimedia tools will accommodate the sophisticated communication skills of the analyst. Tools will facilitate communication with a variety of people who have different needs and objectives and who often use different terminology to talk about similar subjects.

This vision requires both a new culture of analysis and the incorporation of design concepts in presentation tools. *The 9/11 Commission Report* [National Commission on Terrorist Attacks, 2004] points out the difficulties of making adequate information systems part of everyday use in counterterrorism activities. Although there is an awareness of the need for sharing information, cultural change is slow

and must be steadfastly fostered at every opportunity. R&D can make the vision reality, but administrators and policymakers, marketers, public relations personnel, and educators must see to its adoption.

State of the Art

Although significant research is required to achieve this vision, a few systems have made great strides in integrating production, presentation, and dissemination with the rest of the analytical process. One example is the Command Post of the Future (CPOF) system developed by MAYA Viz in partnership with military expert Gen. Keith Holcomb, US Marine Corps (Retired), and private companies Global Information and Telecommunications Institute (GITI), the Institute for Defense Analyses, ISX Corp., Oculus Info Inc., and Polexis. This system is currently in day-to-day use by soldiers of the Army's 1st Cavalry Division to provide security in Baghdad. As shown in Figure 5.1, CPOF "...allows commanders from battalion level and higher to feed real-time situational awareness into the system and have that information available in text and graphic representation immediately by fellow commanders and operations officers at all levels" [Rhem, 2004]. Soldiers share on-the-ground assessments by populating their maps with both hard data and partly formed hypotheses, bypassing the need for lengthy reports and presentations and saving the lives of soldiers who would otherwise need to meet regularly at a certain place to receive the presentations. The mission is also more effectively carried out because of the constant real-time sharing of each soldier's work.

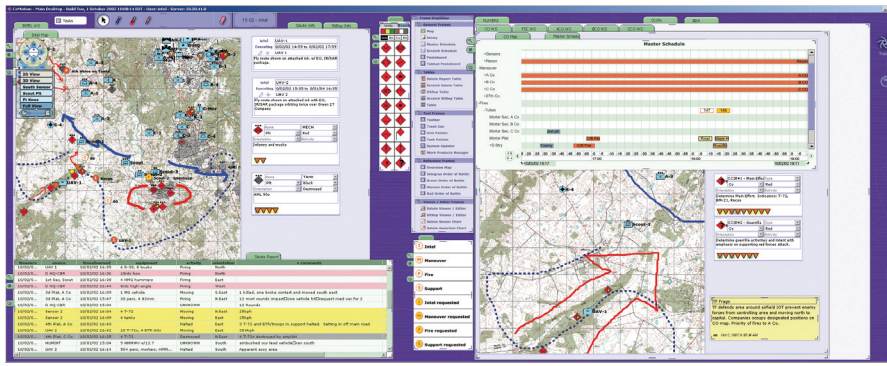

Figure 5.1*. The Command Post of the Future system shows soldiers real-time situational awareness information using a combination of graphical and textual displays.*

Another example is Oculus Info Inc.'s Sandbox system. The Sandbox, shown in Figure 5.2, allows the analyst to organize and work with evidence from multiple perspectives simultaneously [Wright, 2005; Jonker, 2005]. Oculus calls the cognitive space where analysts see and interact with information *nSpace*. nSpace includes both the Sandbox and a number of components for rapid information scanning and assessment.

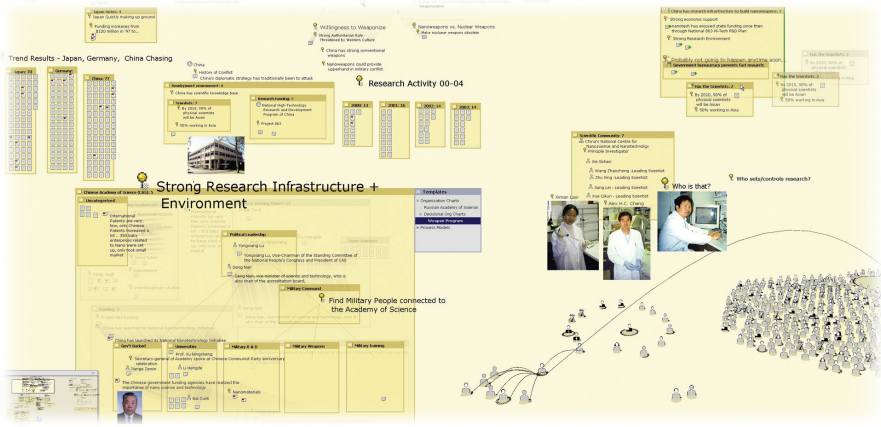

***Figure 5.2**. The Sandbox supports evidence organization from multiple perspectives.*

The Sandbox is a flexible and expressive thinking environment focused on human interaction with information. Manipulation and organization of information is direct and tactile. Analysts construct visible understandings with evidence and hypotheses, and then share them. The Sandbox creates a mixed-initiative environment for the whole analysis workflow as well as a workspace ready for collaboration. The visible thinking in nSpace is the cognitive corollary to the military battlefield.

In analytic practice, however, visually based analysis tools are generally entirely separate from presentation or reporting tools. Analysts can explore data and check competing hypotheses against data from a variety of sources using advanced visualization capabilities, examples of which were discussed in Chapter 3. For composing a presentation or product, they must leave their interactive visualization tools and move to Microsoft® PowerPoint®, for example, to portray their analytical thinking. An integration of analysis tools and reporting tools would improve the production process.

BAE Systems has been exploring the potential for integrating analytic tools with common productivity applications, such as Microsoft Office®, to support analysis. Their POLESTAR software includes a set of lightweight tools for structured argumentation that exist in the background of the analyst's familiar environment and are available for immediate use. These tools enable analysts to collect snippets of information from diverse sources simply by highlighting text. POLESTAR organizes snippets in a repository that analysts browse and search via an interface (Figure 5.3) similar to Microsoft Windows Explorer. This interface allows analysts to drag and drop snippets into Microsoft Word®, where POLESTAR then automatically inserts

source citations, including all security metadata. Analysts can create argument structures either within Word or in an outlining tool (Figure 5.4) that enables the organization of snippets into argument structures comprising claims supported or rebutted by evidence. POLESTAR provides tools for assessing the quality of an argument, including a novel probabilistic measure of the degree to which the structure and content of the argument supports a decision about the claim. POLESTAR enables analysts to merge analysis and production into a seamless process that dramatically accelerates the formation of coherent arguments for or against particular courses of action.

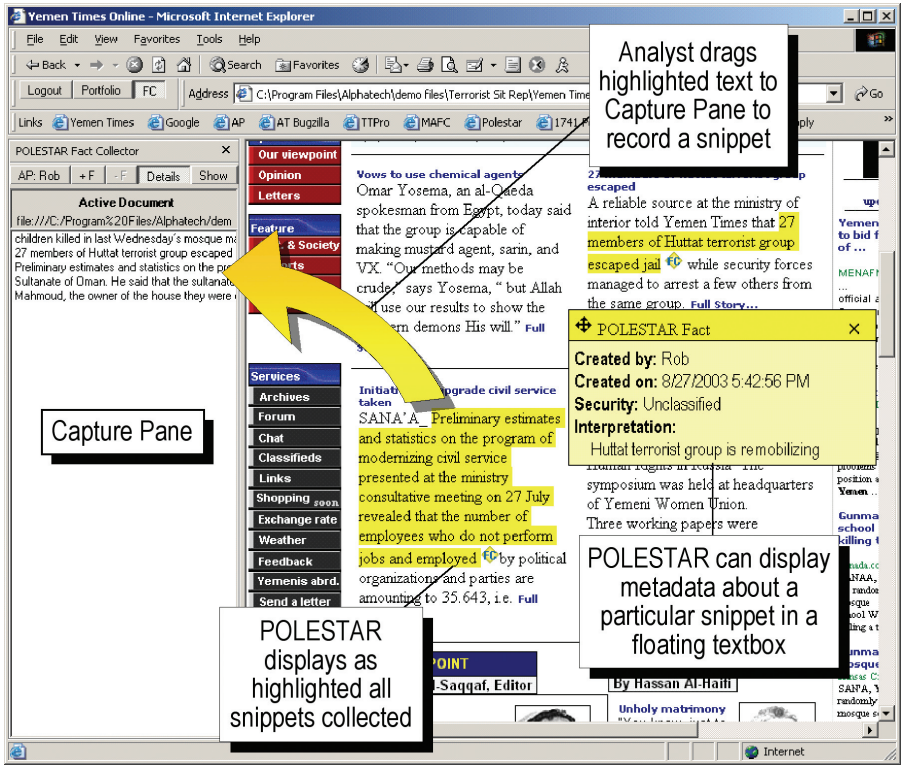

Figure 5.3. *The POLESTAR interface includes a set of tools for working with snippets of information to support structured argumentation.*

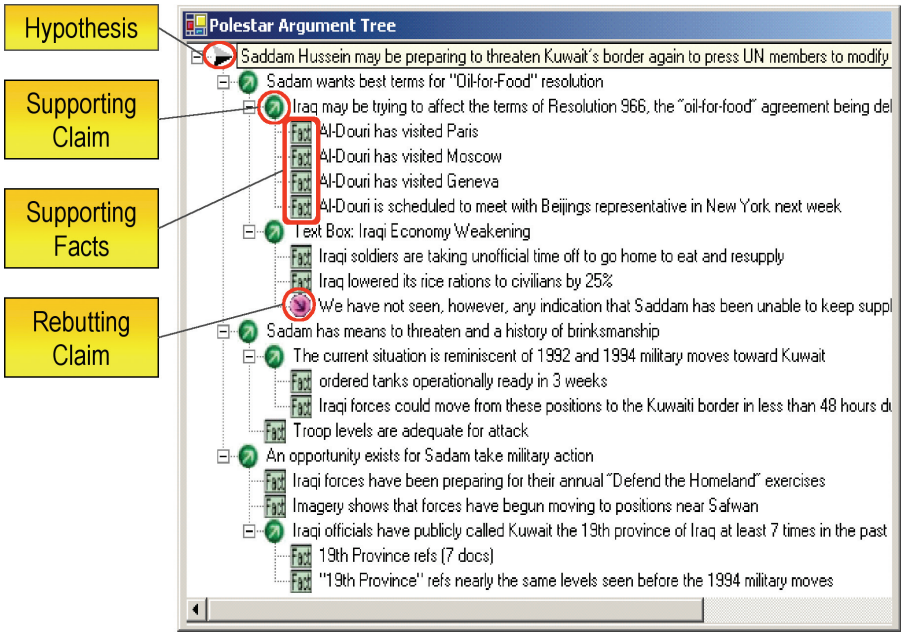

***Figure 5.4**. POLESTAR allows analysts to outline an argument and include relevant evidence, enabling the merging of analysis and production.*

Technology Needs

To accomplish the seamless integration of analysis with production, presentation, and dissemination of results, research must be conducted to achieve several supporting goals: reduce the level of production and presentation necessary by enabling more real-time analytical collaboration; improve the quality of the products and presentations; integrate the creation of products and presentations into the analytical process; and provide guidance and support for the types of communication that must take place.

Recommendation 5.1

Create systems that provide shared real-time situational awareness to teams of analysts.

These real-time situational awareness environments must support sharing of both hard data as they arrive and hypotheses as they are formed and evaluated. Such a capability bypasses the need for lengthy reports and presentations. Although this capability has value in many analytical settings, it is especially valuable in emergency response situations. It gives emergency operations centers a radically better way to understand critical situations, coordinate their expertise, and manage their response [Tufte, 1997a].

In an emergency, the analyst's task is made more complex by the dynamic nature of the data and the unpredictable nature of the emergency itself. We must streamline the relationships among analytic tools, the analytic products, and the uses of those products to support emergency actions. As described in Chapter 2, emergency management and response are highly collaborative activities conducted under extreme time pressure. We must provide systems that allow team members to share their understanding of unfolding events and see what their colleagues are thinking via shareable visualizations that enable efficient collaboration with minimal time investment.

Valuable time will be saved as well if the variety of visual metaphors embodied in the tools provides cognitively efficient perception for the full range of data types. The military can use a map and icons as a basic display metaphor, but analysts may need additional visualizations that relate their reasoning and evidence, as elucidated in Chapter 2, or correspond to their particular area of expertise. The technology must robustly support collaboration, smooth operation across shift changes, and re-use of previous analytic processes and products.

Feedback from the consumers of analysis is critical for any ongoing analytic process. The many professionals who access and use the analytical products need to steer the analysis based on the questions and comments that arise in response to those products. Systems should provide electronic mechanisms for feedback that can affect the analysts' work in the emergency situation without disrupting their analytic activities.

In a rapidly unfolding situation, the analyst must effectively communicate needs for additional data. Current analytic tools assume that the data are complete and do not support a dialog for specifically requesting additional data. Technology is required to allow analysts to state when more data are needed as soon as they identify the need. The need should be transformed into a data request from the best source available at the time. The data should be incorporated into the visual analytics environment as soon as they arrive and the analysts should be notified of their presence.

Recommendation 5.2

Develop technologies that enable analysts to communicate what they know through use of appropriate visual metaphor and accepted principles of reasoning and graphic representation.

Principles for choosing appropriate visual metaphors must be completed. These principles, along with Tufte's dual principles of reasoning and graphical representation of analytic results [Tufte, 1997a; 1997b] must be made actionable in visual analytics software. Analysts operate under significant time pressure and lack formal training in the use of visual metaphor, so these tools must guide the process without constraining the analyst.

An informative example of the analysis and display of evidence is the Challenger O-ring incident, as presented by Tufte. "On the day of the launch of the Challenger, the rocket engineers needed a quick, smart *analysis* of evidence about the threat of cold to the O-rings as well as an effective *presentation* of evidence in order to convince NASA engineers not to launch" [Tufte, 1997a].

Thirteen charts were prepared to make the case, but the charts were unconvincing. The engineers correctly identified the O-ring failure at low temperatures, but the displays chosen to present the evidence did not adequately show the cause of the failure and overcome the bias of decision makers. Displays obscured the data, and the wrong decision to launch was made. The consequences were tragic. In an emergency situation, it will be even harder to make correct decisions. There will be complexities in the data, conflicting requirements, conditional analyses, and intense pressure. It is critical to address the difficult problems of communicating the analysis results to correctly inform the actions of others.

In *Visual Explanations* [1997b], Tufte lists the following dual principles of reasoning about evidence and the design of graphics:

"1. *Documenting* the sources and characteristics of the data
2. Insistently enforcing appropriate *comparisons*
3. Demonstrating mechanisms of *cause and effect*
4. Expressing those mechanisms *quantitatively*
5. Recognizing the inherently *multivariate* nature of analytic problems
6. Inspecting and evaluating *alternative explanations*."

The challenge is to ensure that products and presentations follow these principles. Presentation tools must be powerful enough to communicate different forms of the result for different audiences and analytic situations. They may need to present a single summary visual representation or an entire narrative story, complete with supporting evidence. Assembling a presentation may require pulling together the separate assessments done by multiple analysts. Part of successfully conveying information is explicitly presenting the multiple competing hypotheses that have been considered. Presentations may need to show both the hypotheses and the related evidence that supports or refutes them so that the audience can understand and evaluate the conclusions of the assessment in an informed manner.

Tools must allow multimedia composition with the ease of a word processor. They should facilitate the composition of a complete message, a persuasive argument, a sense of fidelity with the evidence, and collaborative and iterative composition. Composition tools must, at a minimum, contain rhetorical and graphics design support necessary to achieve the production, presentation, and dissemination of clear analytic assessments.

Recommendation 5.3

Create visual analytics data structures, intermediate representations, and outputs that support the seamless integration of tools so that data requests and acquisition, visual analysis, note-taking, presentation composition, and dissemination all take place within a cohesive environment that supports around-the-clock operation and provides robust privacy and security control.

The production and presentation process can be a natural complement to and extension of the analytical reasoning process. The hypotheses, evidence, and conclusions developed during the analysis become important components of the communication of results. By constructing tools that integrate analysis with production, presentation, and dissemination, we can streamline the reporting process and enable the analyst to spend more time doing the analysis.

We must develop standards for visual analytics data interfaces to support the requirements of advanced composition tools. The requirements for persistence of analytic product and presentation must be developed and documented, including tool input and output standards, data structures to support the variety of types of access to analytic results, and the hardware and software infrastructure needed to support emergency operations of the entire team.

Maintaining continuity during shift changes and emergencies can be supported by analytic technology. Visual analytics tools must include an effortless means of recording the results of analysis in a format that can be used during the next shift or in the next emergency. Being able to view and edit logical dependencies and uncertainties as evidence is collected is a critical part of analysis, but it can only be done if the data structures are shareable across teams.

Security and privacy are crosscutting needs. Laws regarding security and privacy of sources, data, and methods must be adhered to. Chapter 6 recommends specific actions to integrate privacy and security protections throughout visual analytics systems.

Recommendation 5.4

Write a handbook for communicating risks in emergency situations.

The book *Risk Communications* [Lundgren & McMakin, 2004] begins to address the problems of communications in emergency conditions. This book covers many aspects of communication, including visual representation of risk and technology-assisted communication. It also addresses communication in crisis situations by adapting the authors' more general techniques to potential emergency situations arising from terrorism or other intentional catastrophes.

The practice of risk communication documented by Lundgren and McMakin provides an important context for risk communications in general, but more work must be done to address emergency communications. We need to describe the members of the communications team and their roles in emergency operations. Best practices for emergency communication should also be identified and documented. These best practices will inform the production, presentation, and dissemination requirements that visual analytics software must meet.

Recommendation 5.5

Develop technologies that capture the results of an analysis, decision recommendations, and first responder actions into information packages that can be tailored for each intended receiver and situation and permit expansion to show supporting evidence as needed.

In an emergency, if only the analysts know the result of an assessment, that assessment has no effect on the emergency response. On the other hand, if the analyst manages all aspects of communicating the assessment, the analyst will not have the time or level of concentration needed to conduct analysis. Visual analytics tools and capabilities must have a straightforward means of packaging the results of analysis in a format that can be unwrapped for just-in-time use by other members of the response team without endangering security or privacy.

The results of an analysis must be communicated effectively to a multiple-level audience in an emergency. The communication will usually be through visual media. Advanced tools are available that take advantage of the visual bandwidth of the human brain to support analysis. The same advancement is needed in tools for supporting composition of presentations or products. The potential for communication far exceeds that addressed in any available presentation or production tools except for those that allow complete sharing of the workspace. The need to incorporate rhetorical and graphics design expertise in composition software will never be felt more than in homeland security.

It is important to make full use of visual approaches to ensure understanding of analytical results. Because of the gravity of emergency situations, tools must attempt to prevent human error at every opportunity and automatically provide an audit trail for review and training. Furthermore, differing audiences may be using different communications devices, so technologies must support clear communication regardless of the type of display device in use. We must develop presentation and production capabilities that ensure accurate, effective, and fast communication to all audiences ranging from first responders to the media to policymakers.

Summary

To be successful in revolutionizing the production, presentation, and dissemination of analytical results, we must incorporate R&D from multiple disciplines and sectors of the graphics industry. The automation of visual analytics naturally and necessarily leads to the incorporation of design and rhetoric into the composition of reports of analytic results. Multiple homeland security audiences and the immediacy of their needs for analytic results will spur the cooperation of visualization and graphic production developers as well as the development of rhetorical design capabilities within the workflow. The future holds the promise of immediate communication of well-analyzed results in emerging and emergency situations in the homeland.

Summary Recommendations

The following high-level recommendations summarize the detailed recommendations from this chapter. These actions are necessary to advance the capabilities for production, presentation, and dissemination.

Recommendation

Develop methodology and tools that enable the capture of the analytic assessment, decision recommendations, and first responder actions into information packages. These packages must be tailored for each intended receiver and situation and permit expansion to show supporting evidence as needed.

No matter what the end information product, the need to describe it, link it to its sources, describe its level of certainty, and put it into the context of the intended user is a time-consuming task. Few scientific methods or tool suites support creation of the end product. This is a high-priority area for near-term investments.

Recommendation

Develop technologies that enable analysts to communicate what they know through the use of appropriate visual metaphor and accepted principles of reasoning and graphic representation. Create techniques that enable effective use of limited, mobile forms of technologies to support situation assessment by first responders. Support the need for effective public alerts with the production of a basic handbook for common methods for communicating risks.

Emergency situations and the need for rapid, accurate communication for informed action by management, first responders, and the public bring to the forefront the need for analysts to effectively communicate what they know. Communications must facilitate teamwork that may include the public as current AMBER Alerts do. To motivate proper actions, the reasoning behind the results must be made as visible as the results themselves to decision makers.

Recommendation

Create visual analytics data structures, intermediate representations, and outputs that support seamless integration of tools so that data requests and acquisition, visual analysis, note-taking, presentation composition, and dissemination all take place within a cohesive environment that supports around-the-clock operation and provides robust privacy and security control.

The task of production can be accelerated and greatly enhanced in quality by a new science, methods, and tools to capture intermediate products of analysis, support mid-level assessments, and support note-taking directly within the analytical reasoning processes. This occurs across the span of information reporting requirements to Congress, to the President, and to the American public. The framework for this must take into account security and privacy policies.

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