

What Ordinary People Need Most from Information Visualization Today

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(This article was originally written for Visualization Viewpoints, a regular section of IEEE's periodical Computer Graphics and Applications. As such, it addresses those who work in the field of information visualization research. Whenever the word "we" appears, it means "we who work in the field of information visualization," especially those involved in research. Although this article was never published in Visualization Viewpoints because of a disagreement with the publisher, IEEE, regarding copyrights, its message remains important and will hopefully still find its way to this audience and will be useful as well to others who are interested or involved otherwise in the field.)

The world needs information visualization (infovis). Our work in this field is important—too important to remain isolated in small enclaves. It's hard to imagine that any of us don't want our work to count for as much as possible in the world. In my role as an infovis teacher, writer, and consultant, I work with a broad range of businesses, government groups, schools, and nonprofits. This puts me in touch with diverse communities that have one thing in common: they must make sense of and present data to do their jobs, and most of them must do so in ways that require little statistical or technical sophistication. These folks don't receive enough attention from the infovis research community. Infovis researchers tend either to work on projects that are technically interesting to themselves as computer scientists or to focus on the needs of professions that are statistically and technically sophisticated, especially scientists. I share Donald Norman's concerns:

I have been increasingly bothered by the lack of reality in academic research. University-based research can be clever, profound, and deep, but surprisingly often it has little or no impact either upon scientific knowledge or upon society at large. University-based science is meant to impress one's colleagues: What matters is precision, rigor, and reproducibility, even if the result bears little relevance to the phenomena under study. Whether the work has any relevance to broader issues is seldom addressed... Most academic study is designed to answer questions raised by previous academic studies. This natural propensity tends to make the studies ever more specialized, ever more esoteric, thereby removed even further from concerns and issues of the world.

(D.A. Norman, *Things That Make Us Smart: Defending Human Attributes in the Age of the Machine*, Basic Books, 1993, pp. xii and xiii)

More often than not, infovis research is narrow in application and stunted in reach. Because of this, I would like to draw the needs of a larger audience closer to the surface of our awareness—an audience whose analytical prowess is perhaps less sophisticated, but whose needs are important nevertheless—often extremely so.

"Infovis can make the world a better place."

I consider it a great privilege to pursue infovis as my life's work. In addition to the way it interests and challenges me, I pursue this work because I'm convinced it's worthwhile. Infovis can make the world a better place. Many problems and opportunities that people face today can be addressed best by, and sometimes only by, infovis. These challenges require people to think, perhaps more and better than ever. Infovis, when applied appropriately and done well, helps people think more thoroughly and with greater insight. We who work in this field are responsible for giving the world visual thinking tools that really work and really matter.

Most data sense-making activities in the normal course of world affairs can be handled by a broad range of people using fairly simple visualization techniques. If you search for resources that teach and support data analysis, however, you'll find many books, courses, and tools that address the sophisticated needs of the few, but almost none that address the simpler needs of the many. Though simple, the skills that are required by the many to make sense of data don't come naturally and the tools that support this effort are in short supply. These skills must be taught, and well-designed tools must be provided, to support cognitively rich immersion in information.

Providing Infovis that Really Works and Really Matters

Several conditions hinder our efforts to provide infovis tools that address real needs in an effective way. Here are a few that I believe we can—and should—work to overcome.

Combating Prevalent Misconceptions about Infovis

What the world of potential users out there knows about infovis—those who know of it at all—is much different from our insider's perspective. Most people know only what they've learned from the often misguided and confusing marketing efforts of commercial software vendors. So, most people either reject infovis as worthless and silly or pursue it using poorly designed products that miss or even directly conflict with its purpose and potential—to help us think more productively. Figure 1 shows a poorly designed dashboard, which represents what many people conceive as infovis. This particular example won top honors in the Crystal Xcelsius Challenge, a competition run by Business Objects, which earned its designer a \$10,000 prize. (A critique of this dashboard is available on my [blog](#).)

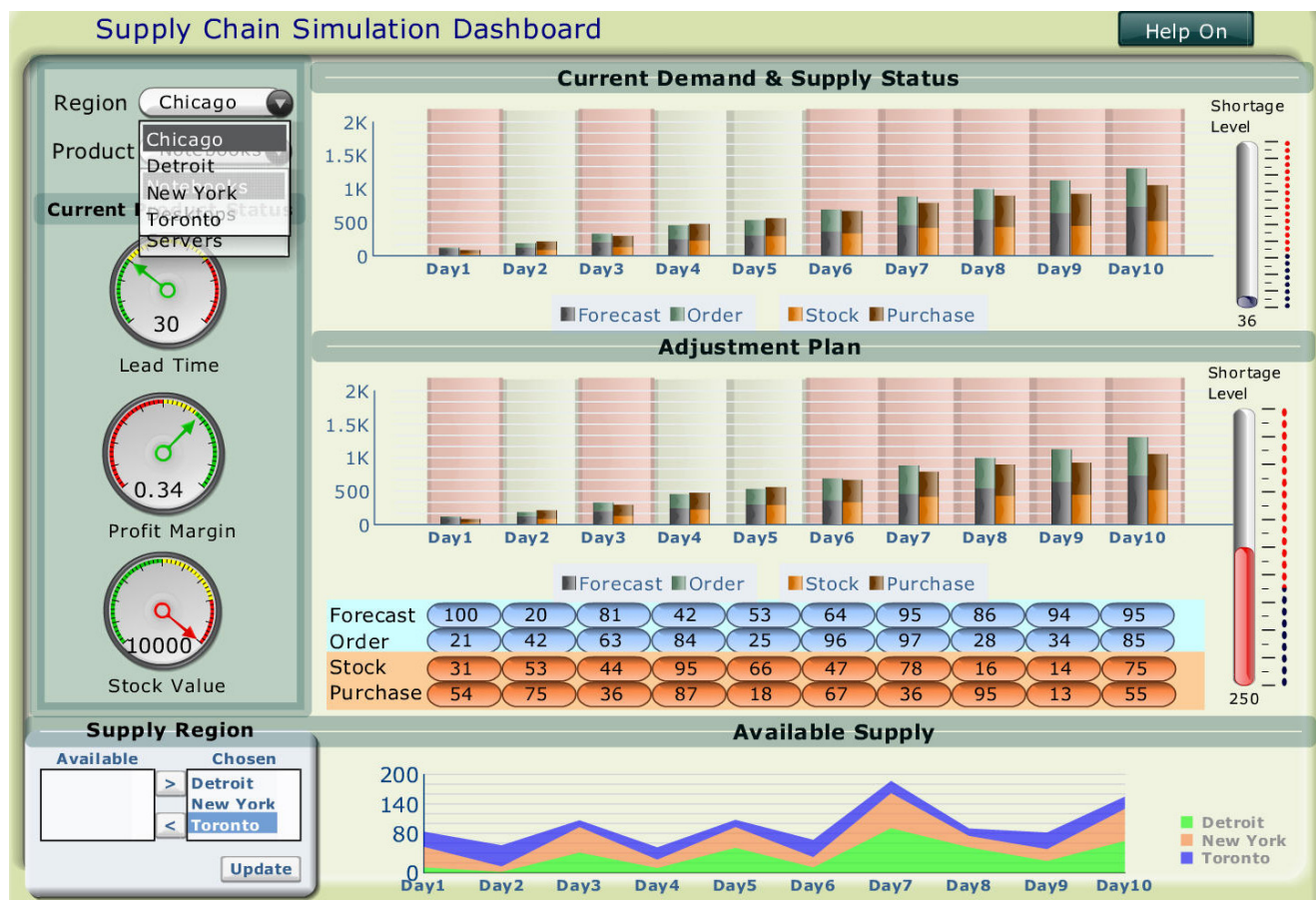


Figure 1. Dashboards such as this are the only exposure that some people have to infovis.

We who understand infovis must raise our voices, and when we do, we must speak clearly. Only when we reveal the best infovis has to offer will the bad examples that mislead people lose influence.

Perhaps no group has incorporated better examples of useful and effective infovis into commercial software than Tableau. Pat Hanrahan, Chris Stolte, and Jock Mackinlay of Tableau Software —three of the brightest and most visionary among us—have ventured out into the world to make their mark. They’ve succeeded by applying the best of infovis to real needs and by refusing to dress up their product with superficial features and glitz to make them appealing to the anemic and misdirected expectations of the business intelligence

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market. They’ve also succeeded by getting to know their customers, learning to speak their language, and demonstrating concern for their needs. They know what they’re doing, and when potential customers see their software, this fact dawns on them, despite how differently Tableau looks and operates compared to most competing products. When the best of what we do is presented to the world and our story is told in clear and relevant terms, people will devour the message and long for more.



Figure 2. Tableau showcases effective, relevant, and accessible examples of infovis to a broad audience.

In the world of Web-based services, Many Eyes (www.Many-Eyes.com) also demonstrates what can be done when effective and useful infovis opens a welcoming door and invites the world in. Martin Wattenberg, Fernanda Viégas, and their colleagues at IBM Research are not only providing the world with an enlightening set of tools, but also building a community around visual data analysis and furthering their own research in the process.

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Few situations frustrate me more than good infovis research that could solve real problems but remains unknown and unused because it has never been presented to those who need it or has been presented only in ways that people can't understand. If we want our message to be heard by those who live outside the walls of the research academy, we must speak plainly.

Strive to express everything as simply as possible. Even fellow infovis researchers will understand you better if you do so. Given the nature of our field, much of our communication to the world involves examples of visualization. Show examples that your audience can relate to and care about. For instance, if you wish to explain your tool's benefits to business people, most of them would cower at the first mention of "combinatorial chemistry," but sales and finance they would understand.

We can also improve communication by infiltrating the ranks of software vendors who offer so-called infovis products but don't really understand infovis. Several vendors sell so-called visualization products but don't even know that the infovis research community exists. I work hard to educate these vendors from the outside, sometimes provocatively, but many of you could educate them from within by becoming their resident experts. By taking a position with one of these companies, you could make a difference that translates into better products, and you would be compensated nicely in the process.

Equipping Infovis Researchers with the Necessary Expertise and Skills

We certainly don't want all infovis researchers to go through exactly the same training resulting in a community of clones, but there are a few fundamentals, other than those typically found in computer science programs, which everyone should learn. Here are a few often-overlooked areas:

- Training in psychology, especially visual perception as it applies to data presentation
- Training in data analysis, including actual experience
- Training in design, especially visual and human-computer interaction design
- Training in the scientific method, including how to design, conduct, and publish robust research studies

Those of us who guide research efforts are responsible both for knowing these fundamentals ourselves and instilling them in our students.

Improving the Execution of Infovis Research

There's no excuse for research in our field that exhibits ignorance of and disregard for the basic principles of visual perception, such as the use of color combinations that people who are colorblind can't discriminate. There's no excuse for experimental research that fails to sample a population in a representative fashion or draws conclusions from tests that fail to control extraneous yet influential variables. These are problems that professors and others who guide teams of researchers should be able to prevent, but these individuals alone can't detect the full range of possible errors. For this, we must rely on the community as a whole—most heavily on our top experts.

A more effective use of critique, such as peer reviews, would help. Since becoming involved with the academic wing of the infovis community only a few years ago, I've been surprised by researchers' reservations about critiquing one another's work and doing so without anonymity. Perhaps some guidelines for conducting these interactions respectfully and constructively would help us more comfortably embrace the practice. I realize that peer review is routinely practiced, but if it were working as it should, we wouldn't see the high number of problems that still remains in published work.

Improving the Effectiveness of Infovis Tools and Techniques

It's helpful to remind ourselves from time to time that our goal is to help people understand information so they can make better decisions. Infovis tools that don't do this are ineffective. Although we've heard it many times, Edward Tufte's admonition is worth repeating: "Above all else show the data" (E.R. Tufte, *The Visual Display of Quantitative Information*, Graphics Press, 1983, p. 92).

Producing work that looks cool but is incomprehensible or meaningless is a waste. Christopher Chabris and Stephen Kosslyn hit the nail dead on when they wrote,

Indeed, the power of software to implement increasingly complex, colorful, and rapidly accessible knowledge visualizations may encourage researchers and information designers to develop representational schemes that will overwhelm, or at least unduly tax, the cognitive powers of the very users they are supposed to be serving.

(C.F. Chabris and S.M. Kosslyn, "Representational Correspondence as a Basic Principle of Diagram Design," *Knowledge and Information Visualization*, S.O. Tergan and T. Keller, eds., Springer, 2005, p. 37)

How can we guarantee that the tools and techniques that we develop are effective?

- They must be designed to reflect what we already know about what works.
- Once they're ready, they must be tested in real-world situations with real world users to confirm that they produce the desired outcomes and do so better than what already exists.
- Unless a tool's purpose is solely to entertain, which I believe puts it outside the realm of infovis, we can't determine outcomes simply by asking people if they enjoyed the experience. Pleasure doesn't equal effectiveness when there's work to be done.

Meeting the Real Infovis Needs of a Broader Audience

If you want your work to matter, you must respond to people's actual needs. Pursuing what interests you is only helpful to others if your interests and their needs coincide; otherwise, your work will matter to no one but you. I realize that academic research cannot and should not always be limited by concerns for immediate practical application. I support academic freedom to pursue an idea without knowing in advance how it will pay off or even if it will. What I'm after is a shift in the balance, not just to applied science but also to science that's applied to what's needed most.

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An infovis project that meets the needs of even one person is useful, but usefulness is measured in degrees. Some projects are more useful than others because they address especially important needs, a broad range of needs, or the needs of many people. I'm particularly interested in the needs of ordinary workers who must make sense of data because projects that address these tend to be useful in all three of these respects. How can we better acquaint ourselves with these needs? Here are a few suggestions:

- Spend time working in the real world doing things that many people do.
- Assist people in their efforts to make sense of information in the real world. Observe what causes them to struggle and look for ways to relieve it.
- Become familiar with the business intelligence industry, which addresses the data analysis and presentation needs of business people.
- Examine existing products—those that ordinary people use—to determine what they lack, and look for ways to fix them.

I know that a few infovis researchers have made this journey and have made a difference. But those who have are too few. Rather than a handful of meager paths connecting us to the world out there, hacked through the forest and barely visible, we need a superhighway.

What Do Ordinary People Need Most from Infovis?

Finally, let me address this article's primary concern. Here are nine critical things that ordinary people need from infovis today:

- *Knowledge of the fundamental skills of information visualization.* We're supposed to be experts in this field, so who's better equipped than we are to teach them these skills?
- *Tools that enable them to easily make sense of data and effectively present it to others.* While we're busy trying to create the next eye-popping generation of information visualization, most people are still struggling to do the simple stuff because existing tools complicate these tasks and undermine their efforts. Long ago, John Tukey expressed what's needed: "When is one expression better than another for analysis? Basically, when the data are more simply described, since this implies easier and more familiar manipulations during analysis and, even more to the point, easier and more thorough understanding of the results." (J.W. Tukey, *The Collected Works of John W. Tukey*, Wadsworth, 1988, p. 12)
- *Tools that make it easy to shift seamlessly between different visualizations and different subsets of data.* The mechanics of moving from one visualization to another and shifting focus from one subset of data to another are still onerous when using most software today. This fragments and consequently discourages free-flowing and thorough exploration and analysis.
- *Tools that seamlessly support the transition from data sense-making to data presentation.* Most of today's tools are designed for either sense-making or presentation, but few handle both well and make it easy to move from one to the other.
- *Tools that make it easy to tell stories.* We're a species of storytellers. There's no reason why even statistical evidence can't be presented as stories, but little work has been done to support this task. The work of Hans Rosling of www.GapMinder.org is an extraordinary exception.
- *Tools that support collaboration for making sense of data.* I'm encouraged by the fine work of our colleagues at IBM Research (www.Many-Eyes.com) who are thoughtfully blazing the trail. We need more of it.
- *Better human-computer interfaces.* Much progress has been made in this area, but more is needed, and the best of what has already been done must be more ubiquitously incorporated into software.
- *Better means to overcome the limits imposed by over-plotting.* Recent research is making a dent in this problem, but must continue and find a home in real tools.
- *Custom solutions to a host of specific real-world needs.* Infovis solutions to specific scientific needs illustrate what we could do in many other areas as well, including business.

This short list is hardly comprehensive, but I hope it's evocative. Use it as a stimulus to create a list of your own and share it with others in our community.

I know that I'm not a lone voice demanding that we do better and reach farther. Others share my concerns and are contributing to the effort, which I appreciate and find encouraging. Let's work together to build awareness of what can be done. And the next time you must come up with an idea for a research project, consider the items on this list—projects that are really needed. Infovis is still a fledgling field with plenty to do that will really matter if it really works.

About the Author

Stephen Few has worked for over 20 years as an IT innovator, consultant, and teacher. Today, as Principal of the consultancy Perceptual Edge, Stephen focuses on data visualization for analyzing and communicating quantitative business information. He provides training and consulting services, writes the monthly *Visual Business Intelligence Newsletter*, speaks frequently at conferences, and teaches in the MBA program at the University of California, Berkeley. He is the author of two books: *Show Me the Numbers: Designing Tables and Graphs to Enlighten* and *Information Dashboard Design: The Effective Visual Communication of Data*. You can learn more about Stephen's work and access an entire [library](#) of articles at www.perceptualedge.com. Between articles, you can read Stephen's thoughts on the industry in his [blog](#).