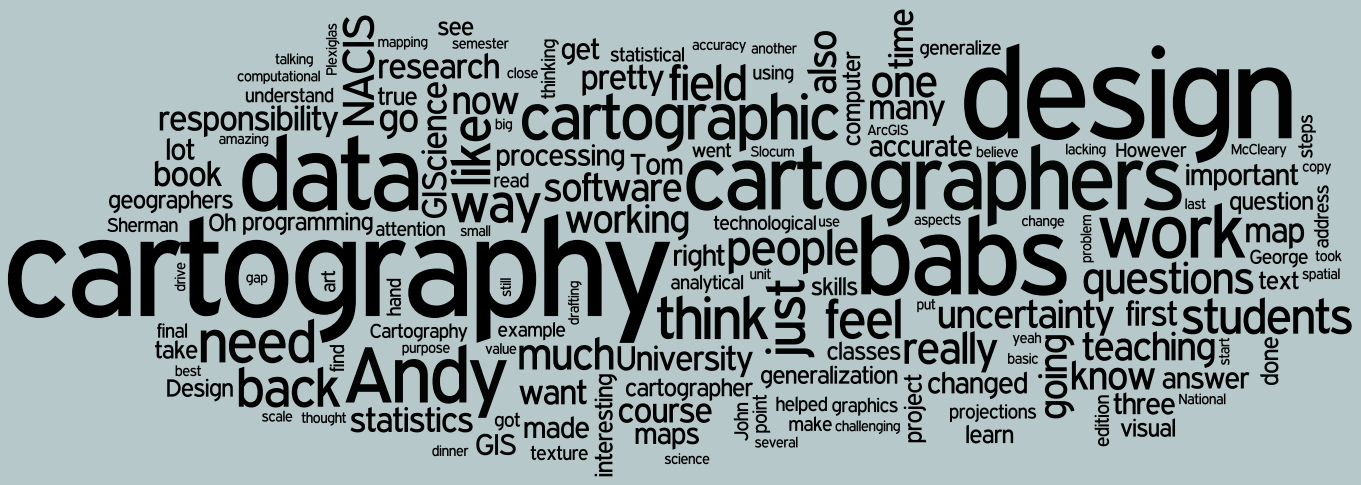
Interview with a Celebrity Cartographer: Dr. Barbara (babs) Buttenfield

Andy Stauffer | astauffer@colorado.edu
Barbara (babs) Buttenfield | babs@colorado.edu



INTRODUCTION

In previous installments of "Interview with a Celebrity Cartographer," well-established designers have been featured. Yet there are many facets to the field of cartography, and a skilled cartographer requires a working knowledge of all areas to create a memorable design. Cartographers who specialize in a few facets bring unique skills and design tactics to the table when creating a map. To embrace the diversity of knowledge that cartographers need, this interview features someone who specializes in map generalization and the mathematic building blocks behind data processing.

Dr. Barbara (babs) Buttenfield earned her master of arts in Geography from the University of Kansas in 1979 and her doctorate from the University of Washington in 1984. After professorships at the University of California Santa Barbara, the University of Wisconsin–Madison, and SUNY Buffalo, she is currently a professor at the University of Colorado Boulder, teaching Geographic Information Science (GIS), Computer Cartography, and Information Design and Representation. She is also the Director of the Meridian Lab, a research facility that focuses on visualization and modeling of geographic information. babs' current research interests focus on cartographic generalization, multi-scale databases, representation of uncertainty, and cartographic information design. She is currently working

with the U.S. Geological Survey to generalize intermediate-scale versions of the National Hydrography Dataset (NHD) for scales ranging from 1:4,800 to 1:1,000,000. She also directs a National Science Foundation project that focuses on refining census-tract-level summary attributes using maximum entropy estimation and dasymetric modeling. babs served on the Board of Directors for NACIS from 2007 to 2009 and was on the *Cartographic Perspectives* editorial board from 1997 to 2001 and from 2008 to 2010. She was the inaugural recipient of the National GIScience Educator of the Year Award by the University Consortium for GIScience (UCGIS) in 2001. When babs isn't occupied with her teaching and research responsibilities, she enjoys fly fishing, working in her garden, and playing music with her partner Bill and friends.

INTERVIEW

Andy: **First, thank you so much for agreeing to be interviewed, babs! I am excited to hear about some of your personal anecdotes and thoughts on the field of cartography. I would like to first start with a pretty traditional question: Why cartography? How did you get into the field; was there any specific event that made you choose this path?**

babs: I was a psychology major at Clark, where I took a course on animal ethology. In the class, we discussed topics such as elephant burial grounds and salmon going up-river to spawn. I got wrapped up in how these animals could have sacred spaces or get back to where they were born without a map. The people who were in the psychology departments in those days, like David Stea, were very literate about geography. So the ethology professor suggested to me, "You should go across the quad and take a cartography course." Afterwards, I studied with George McCleary and never looked back; I changed my major.

The first course in the cartography curriculum was called Skills and Tools in Geography. It was essentially scale, projections, and drafting with all the statistics and number crunching. The class was pretty small with only about 20 students; and maybe seven or eight of us were cartographers. That is where I met the cohort of students that all went through the same cartography courses together. We formed a pretty tight bond, and I'm still in contact with some of them.

The course was challenging because we were all starting from essentially a zero-knowledge baseline. On top of basic mapping concepts, there were calculations, and drafting mechanics. All of the basic statistics were on hand-crank calculators. It was nothing fancy (mean, standard deviations, quartiles, etc.), but it was pretty brutal by today's standards of running to the computer lab and passing the computations through programs like ArcGIS, R, or even Excel. In

Figure 1. Dr. Barbara (babs) Buttenfield.

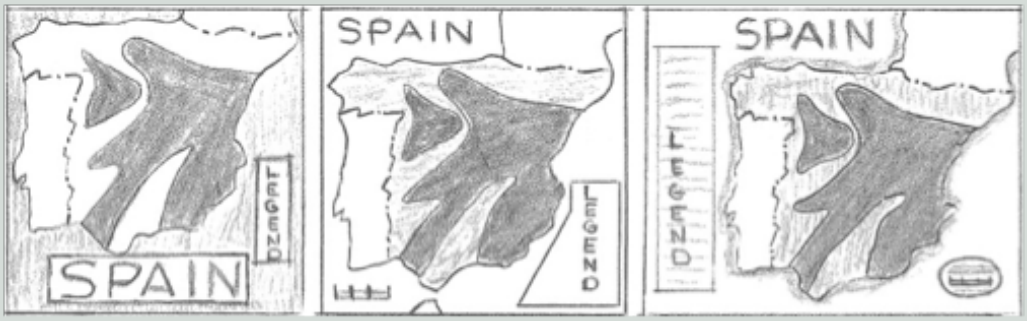


Figure 2. Alternative layouts used to guide students in a Skills and Tools in Geography drafting exercise; taken from Robinson and Sale (1969, p. 265).

another project, we had to draft a small-scale map of the Iberian Peninsula and hand letter it (Figure 2).

Through the class, I discovered that I loved the peace and quiet of drafting. I was pretty good at it; I had a steady hand. It wasn't until later classes that I realized I loved implementing a design strategy and figuring out how to make it work in the wet darkroom.

Andy: **Wow. That sounds like a lot of fun with such problem solving in the lower level classes. It also seems like a perfect undergraduate experience where you get that small group of folks that you just ride to the end with. Let's move down the road a little ways and talk about NACIS. You were on the *Cartographic Perspectives (CP)* editorial board for several years, starting in 1997. You must have seen a lot of evolution in NACIS and CP. Through your experiences, do you have any favorite memories?**

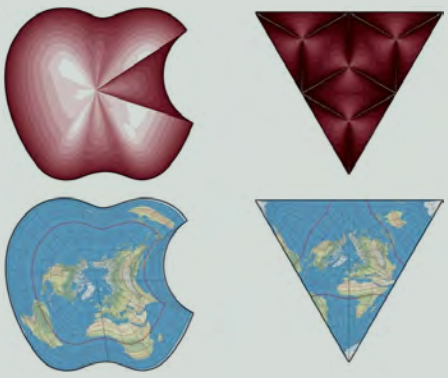


Figure 3. Distortion surfaces created by Quasiazimuthal Equal Area (left) and Snyder Equal Area Tetrahedron (right) projections from Strebe's presentation. Figures from mapthematics.com.

babs: I have a lot of fond memories from NACIS, but the one that comes to mind first was a Pecha Kucha (ぺちゃ くちゃ) in 2007. Jim Meacham did a beautiful slideshow on the work he had done in Mongolia for his atlas. He did an amazing job by capturing the culture, people, community, and sense of place. I'm getting the chills just talking about it.

daan Strebe (2008; mapthematics 2012) did another slideshow with beautiful graphics, which looked like they were airbrushed or done in watercolor with eccentric projections (Figure 3). I distinctly remember how the distortion surfaces of each projection built up in complexity as his presentation progressed. I thought to myself that I was surrounded at NACIS by people who think deeply about the art and science of cartography. That really struck me and is one of my fondest memories of NACIS.

Andy: **That sounds like a fascinating combination of cartography and the mathematics behind it. On the note of cartographic designs that really stand out, NACIS is sponsoring the *Atlas of Design*, a collection of some of the world's best maps. The atlas will honor and showcase maps submitted by cartographers from around the world and will be accompanied by commentaries that lead readers to deeper insights into the designs. *The Atlas of Design* is available for $35.00 and will be a Member Benefit for 25% off the cover price.**

babs: Oh yeah, that seems like a really neat idea; I've already ordered a copy.

Andy: **We have talked a lot about noteworthy and memorable cartographic projects. In your opinion, what do you feel has been your most noteworthy cartographic achievement or project?**

babs: I would say that it was one of my final projects as an undergraduate senior. In one of my cartography design classes, with George McCleary, I built a Plexiglas globe (Figure 4). I laid out the graticule and etched all the coastline work with an electrical pen, so it's a pretty crude generalization. I compiled the linework onto a polyhedron and created a modified Plate Carrée projection. Then I had to cut the Plexiglas gores so it would be a solid container and the pieces would sit right. I didn't plan this carefully, because I thought I could cut the pieces all at right angles—which didn't fit, of course, when it came time to assemble the gores. So I took it over to the Facilities Management Department at Clark and this very nice man, Walter, helped me with the band saw. He beveled all the edges to appropriate angles. We stayed after hours for several nights to do this; I bought beer and hoagies for Walter and his crew. To submit my final semester project, I filled the globe with water and put a goldfish in it. The goldfish has long since died, but that globe still sits in my office to this day.

Figure 4. One of babs' undergraduate final projects for her cartography course: a Plexiglas globe.

Thinking back, I was way out of my league. I should have done better planning for the construction—I just had no clue how to set a beveled edge in Plexiglas. All the maps I've made since then have been flat. But I've kept the Plexiglas globe in my office and still use it in my teaching. (Andy provided the goldfish for the photos.)

Andy: **That's very interesting having your first project not being so much about design, but about projections. So the next question building off of that, is how have your research interests changed? Transitioning from a strong design background to generalization didn't happen overnight, I'm sure. Have there been any significant points in your life that caused these changes?**

babs: That is very true. McCleary is all about design; that's what he did, that's what he does. Once my cohort and I graduated, some of us continued on to the University of Kansas. We went along thinking we were just going to do design and George Jenks said, "Oh no, if you want to be a cartographer, you better get into mathematics, programming, and statistics." He made me go off and learn FORTRAN (so now you know what decade this happened), statistics, and calculus. So, that was the first time my life changed in cartography. I took those classes, then all of a sudden I realized, *OH! You can program this stuff; you can automate it! Cool!*

The second thing that changed my research direction in cartography was when I arrived at the University of Washington to work on my doctorate. John Sherman listened to what I wanted to do, which was to generate an outline of the United States at any scale using fractals. [*babs chuckles.*] But now when I think about it, that idea was so outlandish. He very wisely replied, "I'm not qualified to help. I can assist you with the communication and the design, but I cannot help you with the analytical geometry and the programming." Luckily, the department commissioned Tom Poiker to join my committee as co-chair with John Sherman. Every month, I would drive up to Vancouver and spend a day talking to Tom, and I would drive back to Seattle and work with John Sherman. Those conversations with Tom were pretty wild, filled with amazing ideas; we talked about artificial intelligence, expert systems, and modeling data to generalize automatically. It just made my head spin and threw my research interests for another loop. All thanks to Jenks, who got me thinking about generalization and automation; Tom Poiker, who got me thinking about intelligent programming, or rather informed programming; and John Sherman, who was patient and thoughtful and asked all the right questions…he kept my feet on the ground. Those people really made me stop and take notice of possibilities I had never thought about before.

Andy: **Throughout our educations, we are all bound to have some hurdles. Looking back on your experiences, is there any advice you would have given yourself?**

babs: This probably isn't the answer you are expecting. What I would have told myself back then is to be prepared that I was entering a field that was (at the time) dominated by men; and to make sure to go into the field with much thicker skin than I did.

The kind of work that I do is much closer to GIScience and to analytical cartography than to the design and production aspects of cartography. However, today, that [domination by men] is not as true of cartographic design as it is of GIScience. In the course of my career, women have entered both fields in larger numbers. But the GIScience and cartography communities remain today in some ways distant from each other. I'm very happy the way NACIS embraces what I do, because I don't publish work on design, really. It's not what I do and yet I feel very welcome.

I went to NACIS for several years, then I stopped going for a while. However, I started going back when I was working with Cindy Brewer and Charlie Frye. They encouraged me to come back and I feel very comfortable here.

Andy: **I feel the same way. My first few presentations were on GIS-related topics bridging into analytical cartography. While I didn't feel ostracized, I did feel like my work wasn't quite the same as everyone else's. Yet this led to a lot of very interesting conversations about what I did and how to implement what I had done. After a while, I felt very welcomed.**

This is one of the most challenging questions I have: from a technological standpoint and from a design standpoint, what do you feel the field of cartography is lacking?

babs: I want to answer this question with three answers, not two. I want to add conceptual because I believe things are lacking in all three. The conceptual gap that I see, especially in North American cartography, is a lack of understanding about spatial dependencies, uncertainty, and scale and resolution. We don't understand enough about the errors that we measure or the uncertainties that we bring in by certain processing. For example, when somebody applies a vignette, they are implying that there is gradation. However, we don't know what the shape or size of that gradation is. That's not to say we shouldn't apply vignettes. It's to say that cartographers should consider the analytical frameworks that they are draping their visual basis upon.

The technological gap is not a problem with cartographers, but with the people who build cartographic software, who might also be cartographers. Cindy Brewer and I paid attention to this when we were doing collaborative work with Esri. We were trying to show how the ArcGIS interfaces should work for type, projections, and symbology. It's not set up to go through steps in the sequence that cartographers ordinarily follow; when you are in the ArcGIS interface, you have to start here, and then you have to jump over there; it's not intuitive with the cartographic workflow. I believe that is likely true for other software vendors too, not just Esri, whose staff are working increasingly with users to improve usability. They are talking to cartographers: "How do you do this; how do you think through this?" Improving usability will close a huge technological gap.

In terms of the design, the weak spot that I see are with design principles for dynamic and interactive maps, especially with change detection. Cartographers can play a much larger role in the detection and analysis of change. They could be using visual analytics to bring that about. There are people who are doing that kind of work (Keim et al. 2008; van Wijk 2011). Another area that is lacking is data exploration. I know that statisticians are all working with this, as well as researchers in computer science and engineering. However, they aren't working with cartographers. And cartographers aren't yet banging on their doors either, saying, "Pay attention!"

I'm doing work with some demographers right now and they show me very interesting mapping problems. Recently, I was shown a graphic displaying data and uncertainty. The graphic displays a probability that the demographic categories in an enumeration unit could be categories A, B, or C. So what the person did was to apply random arrangements of pixels for each category within the enumeration unit; the design principle was that more visual noise or coarser texture (more color variation in a unit) means more uncertainty. But the problem is that changing texture also changes the hue and the value, so there is no way to get back to the legend and say this pale red means category A, B, or C. They just didn't understand how conflating value and texture could be problematic for a map reader to understand their display.

These small design choices can have radical consequences. And we as cartographers have become too desensitized to them. We just need to maintain a perspective as vigilant about displays of uncertainty as we are vigilant about displays of data.

Andy: **Do you think that we will address these problems in the future or they are being addressed now?**

babs: Oh yeah, they can be addressed, but to address them, we have to modify the way cartography is taught. I want to be careful here – a lot of people who are teaching cartography are teaching five or six classes a year. Luckily, I have the luxury to spend time on only one or two syllabi each semester. Not all academic cartographers have that luxury. They don't have a working situation that permits much exploration about teaching. So, it's easy for me to say: *we need to modify the way we teach cartography*. But the realistic situation in many places is that this is not an available option. So I say this with caution and with much respect for my peers. We need to be teaching cartography students computation, statistics, and programming. George Jenks was right when he made me learn statistics and calculus, and the same thing is true now. Computation and analysis will continue to be important as pedagogic foundations for cartography and GIScience. I was dragged kicking and screaming myself; now, I tell my own students to learn these skills at the beginning of their cartographic or GIS education because it will allow them to go farther and faster into the subject matter. Curricula that are only teaching the design, art, and graphics are missing an opportunity and are producing generations of students that are not going to be as marketable. They aren't going to have the breadth or depth of skills that cartographers need. Computation is more easily picked up by a geographer than the geographical perspective will be picked up by a computer scientist, which is largely who our students compete with on the job market.

Andy: So, if it were possible, are you suggesting a complete reconstruction of the way cartography is taught?

babs: Not at all. It needs a change of focus, a readjustment of the balance between art and science. Many faculties hotly debate whether it is acceptable to make basic statistics as a prerequisite or concurrent requisite for introductory cartography courses. The best that I could get was concurrent, and that was a very tense discussion in our department. It's not contentious among all geographers; political geographers and the quantitative social geographers see the point. But there are a number of geographers who reply that qualitative methods are just as important. And I agree, to a point. Cartographers need to know how to do a user survey, but they also need to understand how to analyze data. They still need the computational skills. So, is that a reconstruction of American cartography curricula? No; it's a modernization.

Andy: With that said, do you think technological advances—such as graphical software or Geographic Information Systems—have helped or hindered the growth of the field?

babs: I think they helped. But for a long time, cartographers didn't want to adjust to the emergence of GIScience. And that hurt the field of

cartography, particularly the research. I think that many GIScientists concluded, "We don't need those cartographers," and it went to those jokes about *how big is that graduated circle,* or *how wide is that line* or *how dark is that value*. Cartography, as a field, got kind of stuck in these psychophysical questions, right around the time that GIS was emerging as a powerful analytic technology. I think that one reason that GIS software lost track of how cartographers think was that disconnect which grew between the two disciplines. Now, as computer software gives geographers a functionality that permits us to ask and address more complicated questions, the need intensifies for the software to be responsive to cartographic as well as to analytic tasks.

Andy: **So, you suggest that computer software has helped to address more in-depth questions about design?**

babs: It has propelled us from *How big is that… to Let me analyze this spatial pattern to find out if it needs to be bigger*. Or, to take the cognitive perspective, it has allowed us to start using eye movement mapping to find out if the "Just Noticeable Difference" (JND) has actually been achieved. New technologies have changed the way we can think about cartographic aspects of software, about visual analytics, and about how we should be teaching cartography.

GIS technology is not always the only way, and it's not always the best way to find the cartographic solution. For example, manual airbrush hillshading was a dying art until the Swiss cartographers came up with a way to automate the effects of atmospheric haze. The people who could accomplish that manually were all retiring. I've tried my hand at airbrushing and find that I am not very proficient. It's quite difficult to do well. Now I look at the hillshade products coming out, for example seeing the work of people like Alex Tait or Tom Patterson. They take a partially completed cartographic product out of a GIS computing environment, move it into a graphics computing environment, such as Photoshop, and refine the visual quality of the final product.

Andy: **What do you feel is the biggest responsibility of cartographers? (Some examples might be design, accurate data, or appropriate statistical representations.)**

babs: Design, accurate data, proper statistical representations? My answer is all three. I want to qualify this answer—I am not convinced that my responsibility as a cartographer or GIScientist is accurate data. My responsibility is truth in advertising; to tell the map user, "This is the level of uncertainty for this data." I'm not a data collector; I'm not a steward of the NHD; I'm not a remote sensor; I'm not a surveyor. I do process data, though, and I need to be aware of the fact that many of the processing steps I impose on data can corrupt or distort data

accuracy. My responsibility is to be aware of that and communicate that somehow—whether it be graphically, statistically, numerically, or in the marginal text—something to say, "I've processed this data and its uncertainty has changed." But I cannot promise, and don't want to take responsibility for, accurate data.

Andy: **Sure, it's more of taking the responsibility for how you are introducing inaccuracy or uncertainty.**

babs: Yes. But remember that some of the processing steps also reduce the error. The classic example is surveyor's triangulation. The more back sightings there are, the smaller the error triangle gets. My point is, you have to know which kinds of processing or design steps will improve or augment the accuracy. I think that we all know when we put a map into print or disseminate it online, many people assume what they see in the display is "true." Of course it's not necessarily accurate and we need to pay attention to that.

I feel the big responsibility in design is the statistical representation that describes the data accuracy, validity, and reliability. To acknowledge that mapped data is fit for a specific use. So all three (design, accurate data, proper statistical representations) are equally important.

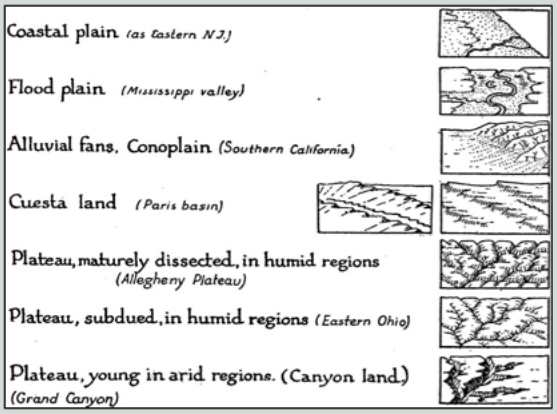


Figure 5. A subset of a table depicting how terrain should be represented on a map from Raisz's General Cartography *(1938, p. 151).*

Andy: **This brings us to the final finishing questions, which I feel are a little bit lighter. Have you been influenced by any specific book or article? Or, do you have any recommendations to those just entering the field?**

babs: Oh yeah! I have a list. First on it is Jacques Bertin's (1983) book on semiology. Visual variables drive so much of what we do, what we try to preserve as we process data and design maps. I generalize for texture; I generalize for shape. Visual variables—there they are. So it is a very important book, even though it is hard for many students to read.

Another book that is important to me is Erwin Raisz's *General Cartography* (1938) text. Even if you don't read it (which you should – you should read every word), at least check out the drawings, the graphics, the text placement, and the linework depicting terrain and vegetation (Figure 5). Take close note of his attention to layout. He was an amazing cartographer. You know the old saying, about if you could have dinner with anyone in history, who would it be? One person I would love to go out to dinner with would be Erwin Raisz. If he would go out to dinner with me, I would be a happy girl. I have so many questions for him.

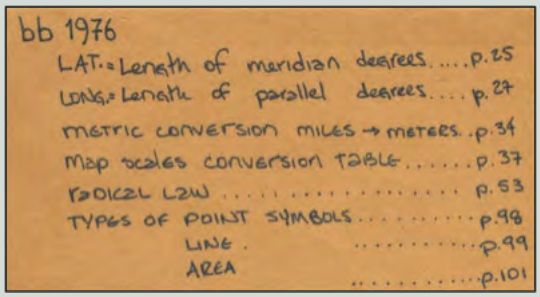


Figure 6. A portion of the custom Table of Contents that babs created in her copy of Elements of Cartography.

A third book is Borden Dent's *Thematic Map Design* (2009). I know the publishers are on the sixth edition now, and I really appreciate what Jeff Torguson and Tom Hodler have done in creating it. I give my students the sixth edition, and I lecture from the fifth. That is the last one Dent put out as sole author, and is my bible on thematic design. I feel as though Dent hit his stride with the fifth edition. It's a great book with clear thinking.

When I use Robinson and Sale's *Elements of Cartography* (1969) text, I go back to the third edition because that is the one I learned with. My copy is full of notes in the margin (Figure 6). I also use the text by Slocum et al. (2008). When I have a question about computational aspects of choropleth classification, for example, Slocum is my desk reference. That has come to be a very important book for me, but I don't assign it to my students; I don't believe first semester cartography students are ready for the depth at which Terry Slocum is writing. I do think that every professional cartographer should have a copy on their bookshelf, and it should be close at hand.

One last item on the reading list is anything and everything Waldo Tobler ever wrote. He really wanted to figure out what was going on in a geographical sense, in terms of the underlying computations, data organization, and processing. If you read his writings, his lifework, you see how a deep understanding of spatial relationships and solid computational skills can permit you to ask (and answer) some very interesting and challenging questions.

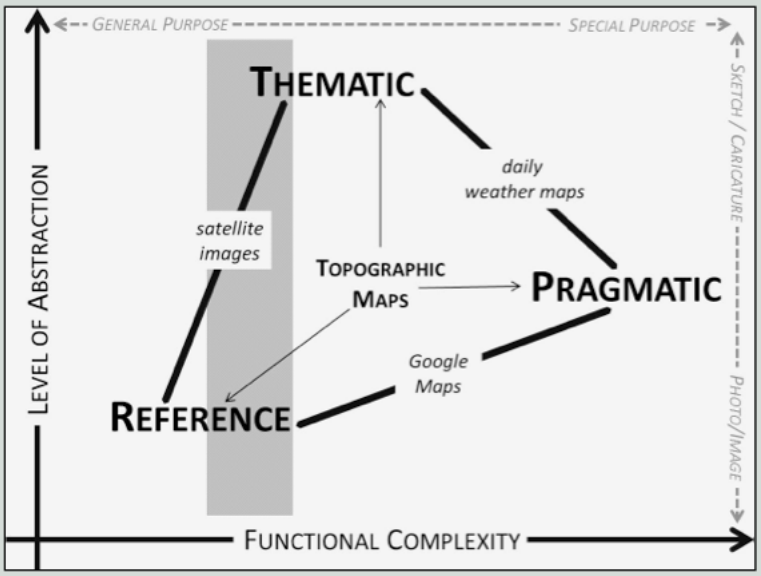


Figure 7. A graphic babs uses for her Introduction to Cartography course to explain the difference between topographic maps in terms of functional complexity and level of abstraction.

Andy: Okay, so last question: reference, thematic, or pragmatic (special purpose)?

babs: Topographic! That is really where my work is going now. It forms the basis for all three. If you learn how to make topographic maps, you will learn how to work with all three types. I'd like to point out in Figure 7 that Aileen Buckley suggested the addition of "general purpose" and "special purpose" to clarify Functional Complexity.

Andy: Oh, I should have seen that answer coming! Well, thank you so much for taking time out of your schedule for me and the readership. Your responses were very interesting and a pleasure to hear about.

babs: Thank you. I have really enjoyed answering these questions!

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