The Development of Physical Globes Based on the GEBCO World Ocean Bathymetry Map
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1. Background: A physical globe is a three-dimensional scale model of the Earth. A globe is the only distortion-free representation of earth's features. Flat maps, regardless of the projection used, portray a portion of a sphere projected onto a flat surface; distortion of the true shape of features is inevitable, and the amount of distortion increases with the size of the area portrayed. Spherical maps, or globes, portray features without distortion. One might wonder how spherical maps are printed, since most printing techniques involve laying ink or pigment onto a flat surface. Large globes are made by printing small areas of the information onto gores, and laying a mosaic of gores onto a sphere, stretching the paper gores as necessary to conform to the three dimensional shape of the sphere. Smaller globes, such as the smaller globes produced in this project, are made by printing a pre-distorted image onto a flat plastic substrate, then thermoforming the plastic into a hemispherical shape under heat and pressure. Two such hemispheres suffice to produce a globe.

In a discussion with Dave Monahan (then chair of the GGC) in 2008, Monahan asked me whether I thought it feasible to get custom globes made, based upon the GEBCO World bathymetric data base. I believe Monahan's question was prompted by an inquiry he had gotten from the company that produces Fledermaus software. I promised Monahan I would look into it.

Subsequently, I contacted globe manufacturers in the U.S., China, and Europe. One company in the US (Columbia Plastics) offered to produce a prototype globe for $50,000 US; no other US companies expressed interest. The only companies that expressed interest in custom globe development without such high up-front costs were Greaves and Thomas, in the U.K.; and several companies in China. After reviewing the products of these companies, I persuaded Greaves and Thomas, and DongXin Globes of China to produce prototypes of their globes for presentation at the GCC meeting in Brest, France in October 2009. I was supported in this effort by Martin Jakobsson of Stockholm University, who provided the artwork and participated in a dialog with DongXin to correctly place the text and cartouche on a large globe. The Greaves and Thomas sample provided for the Brest meeting was a desktop sized globe, approximately 30 cm in diameter; the DongXin globe was a large floor-standing globe of 67cm diameter. The globes were well received by the committee and I was encouraged to continue development, especially on the large globe.

Martin and I continued the dialog with DongXin to improve the image and text on the large globe. IHO agreed to provide funds for a second prototype. The company produced three additional globes, with slight variations in color and text, and invited me to visit the factory to evaluate and select one for shipment. IHO funded a visit to the DongXin company in Shenzhen, during which I selected the most appropriate large globe. During the visit I was also shown some sample of smaller globes which the company had produced, and asked if prototypes of those could be provided as well. I received the prototypes in 2011 and presented them at the GCC meeting held at Scripps in October 2011.

Meanwhile, I had offered to let the Applied Physics Lab of University of Washington exhibit the original prototype of the 67cm globe in their library. It generated such interest that

several academic departments at UW inquired about ordering one – ultimately they wanted five of them. I determined that the only affordable way to get the globes shipped from China was in a sea container, and that I would need to order a minimum of ten globes to justify the shipping and ancillary costs. I polled others who might be interested, and eventually got twelve firm orders – Five for UW, two for John Hall of Israel, one for Martin Jakobsson, one for CCOM/UNH, one for Stockholm University, one for the U.S. Arctic Research Commission, and one for Dale Chayes of Lamont. At the same time I placed the order with the factory for twelve large globes, I ordered eighty 32-cm globes and two hundred 14-cm globes, assuming there would be sufficient interest among GEBCO Project participants to purchase them from me, and reimburse my costs. Figure 1 shows the three sizes of globes thus far produced.

Figure 1. 14cm, 32cm, and 68cm GEBCO World Ocean Bathymetry globes

2. Discussion: The experiences to date in the development, production, and marketing of the various GEBCO globes have been very instructive. A few of the experiences and lessons learned are:

a. It has been difficult to work on the details of the globe layout – colors, map projections, feature labeling, and cartouche – due to language difficulties and possible software incompatibilities. While the company has been cooperative, they were unable to accept some of the projections and text layouts provided by Martin Jakobsson. Color renditions of printed maps are not necessarily identical to the colors portrayed in computer images generated from the same image files; the only way to determine the acceptability of the printed map image is to subjectively evaluate a prototype, and order the production maps

using the same color palette. In the case of the globes, produced in Shenzhen, China (near Hong Kong) it was necessary to visit the factory to perform this evaluation. Even then, the evaluation did not catch all the possible errors in the design of the globe. I was necessary to modify the 32cm globes shipped to Monaco, following the lengthy development of a retrofit parts kit by the factory, in order to correct an error on the scale of the latitude ring.

b. Shipping of globes to recipients in various countries has been one of the most difficult efforts in the manufacture and distribution of globes. We must understand that, since globes are mainly hollow spheres, they are very light for their size. International freight rates for sea shipment are straightforward; the rates are based on origin, destination, and volume. So, for example, a standard 20 foot shipping container can be shipped by sea from Hong Kong to Seattle for a fixed tariff, say $800; to that cost must be added costs for packing and documentation at the origin; cost for documentation, customs bond, customs inspection, customs clearance, inland transportation, unpacking/repacking for customs inspection, insurance, and warehouse storage at the destination. If the 20 foot container is loaded with twelve globes, a one twelfth portion of all the shipping/transportation costs must be assessed to each globe in the shipment. If the container is loaded with thirty globes, the portion of shipping cost allocated to each globe is smaller.

Consideration was given to having the company in Shenzhen split the order at the origin and, say, ship a single globe to Stockholm, two globes to Israel, etc. However the company was unwilling to consign globes to anyone except a full-service freight company such as Federal Express, which would have drastically added to the cost of each globe. (All the air freight rates are based on something called “volume weight” in which the customer is charged for the higher of the actual weight or the weight determined by the measured volume multiplied by a predefined density figure. In the case of the large GEBCO globes, each globe in a box weighed approximately 35 kilos, but air freight rates are calculated on 170 kilos due to the size of the box.

Since no reasonable shipping rates could be arranged for distribution direct from China, I opted to ship by sea container to Seattle, since the US does not charge customs duties on globes, and break down the sea container for onward shipment to customers, by obtaining competitive bids from freight forwarders. Twelve large globes were shipped to Seattle in a 20 foot container. I was able to put into the shipping container, at no added cost, eighty of the 32-cm globes and 300 of the 14-cm globes. Shipping the large (67-cm) globes onward from Seattle to destinations across the Atlantic was still quite expensive, even with the opportunity to shop for competitive rates. Typical transatlantic shipping was about $1000 for a large globe. Inland shipping, to destinations on the East Coast of the US, was about $350 per globe.

Shipping of the smaller globes, by postal service or parcel delivery service, was also a significant addition to the cost of the globes.

If there is sufficient demand for large globes from European institutions, a more cost effective means of shipping would be to consolidate all European orders into a sea shipment which could be consigned to a free trade zone such as that in Bremerhaven, and from there arrange ground transportation within Europe.

c. A third difficulty in the production of globes in China had to do with the actual funding to pay for the globes. The Chinese companies will absolutely not release product to shippers until the company has been paid in full, in US Dollars, for the product. I was able to persuade a few of the customers who had interest in the large globes to place an order and pay in advance for the product and all shipping costs. However, this is not the preferred nor normal way of doing business for government agencies and institutions. In order to place the order for the globes to be produced and shipped, I was required to wire funds from my bank to the bank in China; In order to trans-ship globes from Seattle to ultimate destinations, I was required to pay the air freight company promptly; and then request payment from the recipients upon receipt of their globes, so I could restore the funds to my bank account. In the case of any delays in shipping, or any technical problems with the globe products, that meant that my personal funds were encumbered until problems were resolved or shipping delays overcome.

Because of the relatively high cost of large globes, and the requirement that the company be paid in full prior to shipment, I was unable to place an order for a full shipping container full of globes, thus adding significantly to the per-globe cost of shipping.

3. Recommendations:

a. I believe that globes are the ideal way to present geographic information, such as the GEBCO world bathymetry. By studying the features on the seafloor without the distortion associated with flat map projections, students can readily visualize geologic processes and tectonic plate boundaries. Twelve of the large 67 globes produced thus far in this project, and over forty of the 32-cm globes, have been placed in educational institutions.

b. I think it may be possible to establish a distributorship for the smaller (14cm and 32cm) globes in Hong Kong or elsewhere in China, where the globes are produced, from whom interested customers could order globes to be shipped anywhere in the world. I know, from experience ordering merchandise from China, that distributors there have inexpensive shipping options not available in the United States.

Before the project to develop the GEBCO globe, I developed an umbrella based upon the IBCAO map of the Arctic. After fulfilling orders for several thousand of these umbrellas, I see that several Chinese companies are offering the Arctic umbrella for sale, both retail and wholesale. I believe the same thing can happen with the globes, if a distributor in China is persuaded that there is a customer demand for the product.

c. If it is decided that distribution through a Chinese company is desired, GEBCO should be involved in the design, specification, and quality assurance of the product to be marketed. This may involve establishment of a working group to liaison with the Chinese manufacturer and distributor, and a review of prototype products prior to an endorsement by GEBCO that they do, in fact, correctly portray the GEBCO world map.

d. A program to go forward with the larger (67 cm) globes must be structured differently. The large globes are expensive to manufacture, and are difficult to ship because of their size. I note that there is one globe company, Columbus Globes of Germany, who offers a globe of 77cm diameter, at a price of around $10000 USD, and the price does not include shipping.

If we are to produce more of the large globes (and please note that 67cm is not a size limit; the manufacturer can produce globes up to 1 meter diameter) then we must find a way to pay for a quantity of globes at the time of order, and receive payment for the globes on delivery. Perhaps IHO could serve a role in this, establishing a corpus of funds to enable the globes to be manufactured, and replenishing the funds when the globes are delivered. The cost of our 67cm globes, out the door of the factory, is about $2000 USD each. There is no customs duty assessed on globes shipped into the United States; this is not true of countries in the EU, where duties of 15% or higher may be assessed. I do not have any information about customs duties in locations other than the US and the EU.

I propose that the GEBCO Guiding Committee circulate an inquiry to determine the level of interest in globes, among individuals and institutions which participate in GEBCO, in order to help decide how to structure a way forward with the globe project. For purposes of this inquiry, it would be well to advise institutions of the likely cost of the globes.

I believe that if we can establish a distributor in China for the smaller globes, the cost to the customer might be kept below $20 each for the 14cm globe, and below $150 each for the 32cm globes. These costs presume that the Chinese distributor has a means of shipping the 14cm globes internationally for less than $5, and the 32cm globes for less than $50.

A target price for the 67cm globes would be $3500 each, plus customs duty. This presumes shipment by sea.

I am personally unable to underwrite the cost of further development of the GEBCO globes. If my assistance is required in liaison with the Chinese globe company or its representative (in Hong Kong) I would be happy to participate as a paid consultant to IHO or another GEBCO participant organization. I believe our Chinese colleague, Professor Shaohua Lin, might also be an excellent liaison in dealing with companies in China.