ScaleMaster.org: Illustrating and constructing the multi-scale mapping process

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Multi-scale mapping describes the cartographic practice of providing integrated, legible designs of the same geographic themes at numerous scales (Spaccapietra et al. 2000). The process of multi-scale map design in many cases is a manual one full of repetitive tasks, and often the impact of these choices on the total workload is unclear as they are made. The quality and efficiency of a multi-scale mapping project that maintains map legibility can be improved, however, by identification and maintenance of key scales, termed *decision points*, requiring one or several kinds of modifications, termed *multi-scale mapping operators*, that are applied to the represented feature types. This approach addresses multiple challenges of multi-scale mapping: (1) it is not feasible to capture data at each desired scale because of time, cost, and storage constraints; (2) it is not efficient to capture or maintain data at each desired scale because of data redundancy; (3) it is not possible to capture data at each desired scale when the mapping implementation needs to meet demands for an infinite and dynamic range of scales; and (4) it is desirable to update the spatial datasets or revise the multi-scale mapping operators only once, propagating modifications to all scales.

This paper reports on the construction of *ScaleMaster.org*, a web-based cartographic tool for developing and organizing multi-scale mapping projects. Originally sketched in 2003 during ESRI planning meetings by Charlie Frye, the ScaleMaster concept since has been formalized in a pair of publications (Brewer and Buttenfield 2007; Brewer et al. 2007). The *ScaleMaster diagram* represents each feature type as a stack along the vertical axis and the range of project scales along the horizontal axis. Each feature type, grouped by theme, has an associated rectangle that extends across the scales for which the feature type is displayed. Decision points are marked and labeled with a sequence of codes indicating the multi-scale

mapping operators necessary for maintaining map legibility at and beyond the decision point. Figure 1 provides an example ScaleMaster diagram.
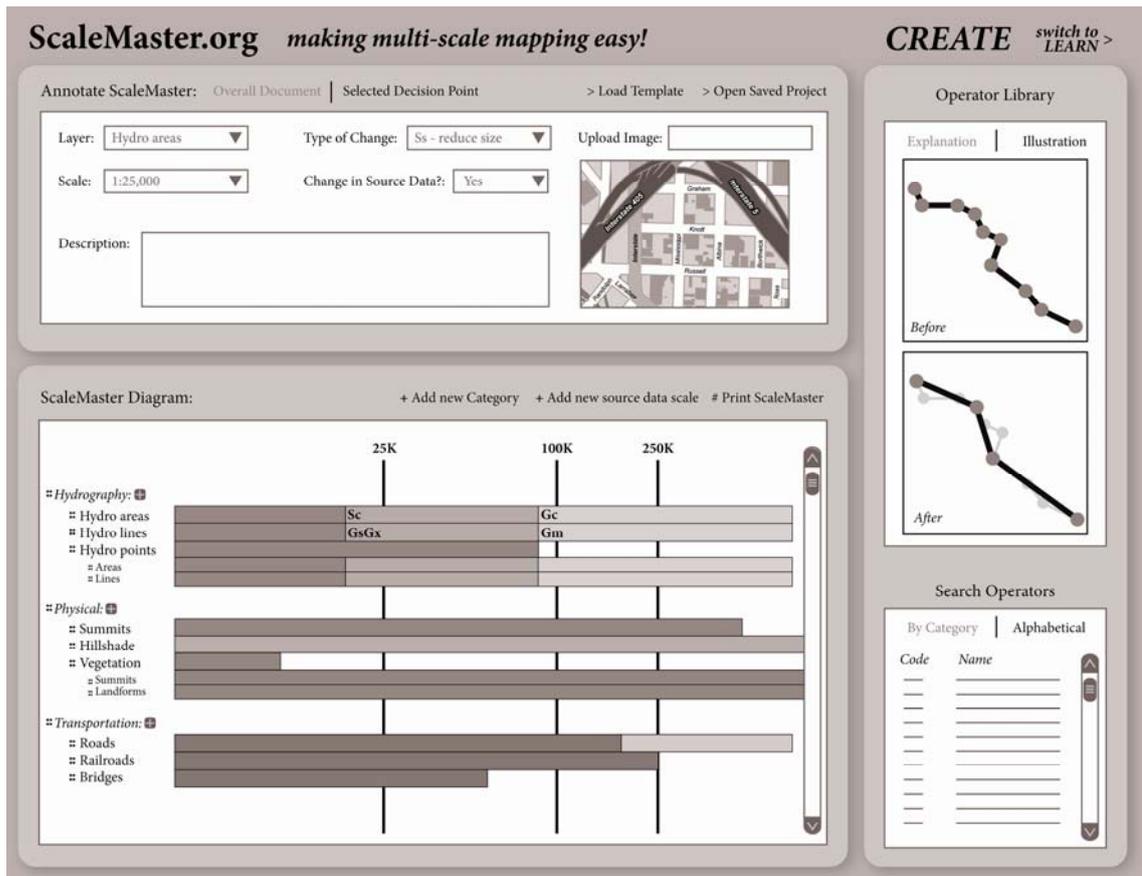
The ScaleMaster.org tool transitions the ScaleMaster concept from a static graphic for summarizing decision points and the accompanying multi-scale mapping operators to an interactive, online tool for education of multi-scale mapping principles and iterative development of scale-dependent design specifications for multi-scale mapping projects. ScaleMaster.org falls in line with a new class of cartographic tools inspired by the prevalence and preference of digital media and web-based dissemination (for an example of online assistance with cartographic generalization, see Harrower and Bloch 2006). These tools are designed not to automate the cartographic process completely, but to provide simple interfaces that explicate and assist a particular aspect of cartographic design. The ScaleMaster.org tool provides two modules with the interconnected purposes of multi-scale mapping education (the *Learn* module) and assistance for multi-scale mapping practice (the *Create* module).

The Learn module allows for education on multi-scale mapping through three dynamically linked panels: (1) a library of multi-scale mapping operators, (2) a ScaleMaster diagram for an example multi-scale mapping project using all of these operators, and (3) a pair of maps illustrating before-and-after designs for a user-selected decision point on the ScaleMaster diagram. Descriptions and illustrations of multi-scale mapping operators are provided in the illustrated library and are linked to the decision points in the example ScaleMaster diagram, providing explanation of the multi-scale mapping operator codes (specific multi-scale mapping operators included in the ScaleMaster.org site are discussed in a companion poster). A slider bar widget allows the user to brush through decision points on the ScaleMaster diagram, updating the two map displays. Although both map displays are at the same scale, the first display shows the map design prior to the decision point (the *before* map) while the second illustrates how the legibility issues were resolved by the multi-scale mapping operators implemented at the decision point (the *after* map). The three linked views allow the user to interactively learn (1) what multi-scale mapping operators are available and what they mean, (2) what the ScaleMaster diagram is and how multi-scale mapping operators are organized in it, and (3) how the multi-scale mapping operators improve map legibility. The draft interface for the Learn module is provided in Figure 2**.**

The Create module facilitates the construction of a ScaleMaster diagram specific to a user's multi-scale mapping project. The user has the option of beginning with a blank ScaleMaster diagram or with the example ScaleMaster diagram from the Learn component. The user can then add new categories, new feature types, and new decision points, or may adjust ones that are currently present. The library of multi-scale mapping operators remains visible, allowing the user to drag an operator directly onto a decision point. The ScaleMaster structure is stored on the server using an XML data format, allowing the user to adjust the ScaleMaster diagram over time or share the specifications with other project members. If consent is given by individual users, the multi-scale mapping projects generated by the Create module will be included in a future research study aimed at formalizing rules of use for multi-scale mapping operators based on cartographic practice. Alternatively user results may demonstrate that multi-scale mapping is such a customized process that consistency in operator use does not yet exist. The draft interface for the Create module is provided in Figure 3.

Redesign and generalization are difficult and time-consuming aspects of mapping across scales. Creating a structure to organize and collect data on the practice of successful multi-scale mapping is a first step to improving tools and guidance on best practices for dynamic mapping for wide ranging purposes from varied data sets. The ScaleMaster.org project is an initial step toward this goal.

FIGURES

Fig. 1: An example ScaleMaster diagram. The vertical axis marks the various feature types included in the multi-scale mapping project while the horizontal axis marks the range of design scales for the project. Map themes are marked with different hues when color display is available.

Fig. 2: An interface mock-up of the Learn component.

Fig. 3: An interface mock-up of the Create component.

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