Transactional Map Symbols –
At the Crossroads of Cartography?

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Abstract

Under the auspices of ubiquitous computing digital maps are becoming a key application to interact with augmented space. Thereby the role of digital maps shifts from being a medium of static communication about space to a geo-/graphical user interface (GeoGUI), with map symbols as a key element in GUI design. These map symbols serve as entry points for location-based communication, interaction and real world transactions. Accordingly they are termed “transactional map symbols”.

Whereas a well-established set of design rules for map symbols is provided in cartography only vague, formalized guidelines for the design of transactional map symbols exist within the broader context of map facilitated platform and interface design. Additionally it has to be considered that in the wake of the Web 2.0 paradigm geospatial technology and especially maps are designed and used mainly by cartographic laypersons.

This paper attempts to unfold basic aspects of transactional map symbols and drafts a further research agenda for geospatial interaction design that considers cartographic principles more explicitly than it is currently the case.

1 Introduction

The increasing popularity of computer embedded devices is creating new forms of communication and interaction between people and things. Ubiquitous computing is continuously adding and retrieving information to and from an augmented space. Geographic information media are a baseline for any application in this field as they allow for a seamless transitioning between the virtual and the physical space (BLASCHKE & STROBL 2010). Social navigation (BILANDZIC & FOTH 2009b) and collaborative information generation becomes much easier due to interactive map facilitated applications for any device. Thus the role of digital maps as a key application to interact with augmented space redefines their core purpose. It is shifting from a pure representation of spatial entities to an interface for any kind of communication (e.g. describing, rating, and commenting) about or interaction (e.g. ordering, booking) with those entities. Thus a map becomes a geo-/graphical user interface (GeoGUI) for any application with location-based content (BRODERSEN 2008) where the physical space (location) serves as organisational structure for all map facilitated activities.
In recent years, following the Web 2.0 revolution (O'REILLY 2007) a tremendous rise in the number of such GUIs in portals and websites is observable. Beside the increasing ease of map integration via web mapping APIs, the main reason for this trend is related to the general popularity of the maps as interfaces to the real world among users. It seems that the utilization of location for indexing datasets (HAKLAY et al. 2008) is that successful because it ties in with the competence of users to orientate and act in space.

Within such GUIs a special category of (mostly) point symbols like pushpins or simple markers are used as entry points to location- and object-based interaction, and therefore can be considered as a key element in GUI design. However, at a first glance those “transactional map symbols” show a very rudimentary (in some cases even poor) design, at least from the viewpoint of professional cartography. Is this just due to mashup makers acting as “accidental cartographers” implementing a “bastard cartography” (cf. UNWIN 2005: 683), or might there be other reasons as well?

Since little research has been done into how geospatial technology interfaces can be designed for non-experts (WARDLAW 2010), this paper attempts to lay a foundation for such research. After a discussion of functional and accordingly graphical differences between conventional and transactional map symbols, various aspects affecting transactional map symbol design are identified and discussed. The paper concludes with a perspective on further research aspects.

2 Web 2.0 and the Shift from Cartography to Geo-Interaction Design

Originally cartography has been the art to represent reality as accurately as possible for specific purposes – maps served as real world models with a certain degree of abstraction and generalization. For this process an elaborated, balanced set of cartographic guidelines has been defined. These guidelines are based on traditional conventions, experience and findings in the field of visual perception and cognition (BERTIN’S work (1983) for example is regarded as fundamental). At this stage, the role of the map was to serve as medium in a traditional sender-recipient relationship, a concept which is widely outdated due to a paradigmatic shift driven by enormous technical and cartographic advancements (FABY 2009).

The technical opportunity to integrate dynamic, interactive elements (e.g. hyperlinks, multiple views, animation, etc.) in digital maps marked an important peak of innovation in the history of cartography and geovisualization (cf. DiBiase et al. 1992 or EDSALL 2009), allowing the user to thoroughly explore geographical data in multiple dimensions. Approximately 15-20 years later the establishment of the Web 2.0 paradigm (O'REILLY 2007) indicated another turning point, strongly influencing the practice of mapping. Accordingly HAKLAY (2008: 2011) speaks of the “GeoWeb 2.0”, with so called map mashups as major map elements. They allow for connecting an abundance of location-based information from different sources within one map. In the wake of this development the functionality of maps changed from a static representation to a connective interface, blurring the boundaries between virtual and physical space. This trend towards a seamless interaction in an augmented space is further intensified by mobile devices, which turn environments into pervasive computing spaces (HAGRAS 2007, FROEHLICH et al. 2008).
Putting together the enormous technical advancements, both concerning hardware and software, and the conceptual shift in the wake of the Web 2.0 establishment, a more flexible understanding of maps seems to be required (Brodersen 2008): “community activism” and “social networking” are identified as two core elements of map-based platforms by Foth et al. (2008: 7) – aspects which are pretty novel in the context of cartography. Both elements strongly relay on folksonomy (collaborative classification) and geotagging (adding spatial references to all kind of entities) as functional design aspects as well as tools for information management (Bilandzic & Foth 2009a). This trend is definitely not driven by professional cartographers and therefore cartographic guidelines are largely ignored (Frye 2009). Beyond community rooted, communication oriented map applications (e.g. PPGIS), maps are increasingly used for immediate location-based interaction both in virtual and physical space. In contrast to communication about places in a purely virtual environment, interaction in the context of transactional map symbols is directly connected to real world social behaviour patterns (Kindberg et al. 2007: 19) and individually triggered actions. Foursquare1 where you can directly benefit from a map based transaction (“Check in and gain a discount.”) would be an example of application. The functional and paradigmatic shift from traditional, static cartography to a broader context of geointeraction design as described so far is illustrated in figure 1.

![Fig. 1: The evolution of the digital map from a static communication medium (left) to an interface for communication (middle) to an interface for interaction in an augmented space (right).](image)

In the utilization of maps as interfaces map symbols can be key elements in graphical and functional terms. They do not only represent corresponding real world entities as such, but possess transactional abilities and serve as connectors between virtual and physical space. Therefore this type of symbols is named “transactional map symbols” in order to emphasize the larger functional extent compared to interactive symbols (e.g. hyperlinks). Most often pushpins (or equivalent symbols) are utilized for transactional map symbols, since they are

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available in nearly every standard web map API (OXLEY 2009). Alternatives like OGC-conform web services seem to be still reserved to experts (HAKLAY et al. 2008).

Transactional map symbols are applied in several contexts:

a) Collection of location relevant information (e.g. Google Places$^2$): any information for a specific place, shop, restaurant etc. is collected and tagged.

b) Location-based collaborative content (e.g. Qype$^3$): any kind of information, ratings and comments are user generated and can be edited by any member of the platform.

c) Location or object based real time information (e.g. Public Transport$^4$): real time information is connected with symbols representing either locations, like bus stops, or moving entities. Platforms communicating real time whereabouts of persons enjoy rising popularity (e.g. Foursquare$^5$).

d) Location-based interaction (e.g. Booking Portal$^6$): opportunities to interact with places/objects are directly bound to map symbols (e.g. “book now” button in a map overview of hotels or maintenance requests in communal web applications). Interaction with localized persons (FIELD & O’BRIEN 2010) is provided by several platforms (e.g. Trendsmap$^7$).

e) Augmented location-based information and interaction (e.g. Wikitude$^8$): real world environments are overlaid with location-specific information. Mobile devices with integrated positioning systems and active internet connection serve as tools for “mobile spatial interaction” (BILANDZIC & FOTH 2009a).

All referenced examples (cf. footnotes) clearly illustrate that the design of such symbols is not merely a matter of cartography anymore, but of a more general geomedia- or geo-interaction design (BRODERSEN 2008). Most authors agree that existing applications are technically well established, but a sound design concept is still lacking, since requirements, application domains and devices are very diverse (BILANDZIC & FOTH 2009a; CHOI et al. 2010; SCHOBESBERGER 2010). FROEHLICH et al. (2008: 18) put it this way: “Presenting spatial information and various details about the location and the people in the location without provoking cognitive overload is an interesting and challenging interaction design task.”

3 Current Design of Transactional Map Symbols

Within the general discussion of geo-interaction design in a Web 2.0 context transactional map symbols as connectors between virtual and physical space play a central role as discussed in the section above. Their functional enhancement compared to traditional map symbols is obvious, but it is doubtful if an according graphical conceptualization, in a cartographic sense, keeps pace. As a first step, an inductive case study of various applications aims to extract core design elements as currently utilized. This should serve as

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$^2$ http://googleblog.blogspot.com/2010/04/introducing-google-places.html [10.01.2011]
$^5$ http://foursquare.com/ [10.01.2011]
$^6$ http://www.hrs.com [10.01.2011]
$^8$ http://www.wikitude.org/en/ [01.02.2011]
a basis for a more in-depth discussion and research about the potential “cartographic impact” in geo-interaction design, building somewhat like a counter weight to a pure web design approach.

Transactional map symbols are mostly based on point geometries for at least two reasons. Firstly, pushpins are available for mashups in nearly every web map API. They can be connected with any information relevant for a specific location. Secondly, point symbols require little space on the map and consequently more information associated to the displayed area can be communicated. Take for example an urban park with several facilities like an ice-cream parlor, a fountain, benches, restroom etc. A communal information web portal wants to tag all these entities with transactional map symbols for feedback or maintenance requests. Given that the park is stored as a polygon feature it would not be advisable to derive a polygonal hotspot because entities within the park would be “covered” and could not be targeted distinctly anymore. The obvious and most practicable solution is to represent the park itself and every facility within as a point symbol, as shown in figure 2.

**Fig. 2:** Transactional map symbol “Central Park” as polygon (left) vs. points (right); hotspots are indicated by grey shading/circles and hyperlinks. The usage of points as transactional map symbols prevents hotspots from overlapping.

Compared to a traditional utilization of map symbols (cf. JONES 2010: 145 f.), transactional map symbols are rather basic in terms of graphic complexity. In most cases they are based only on one graphic element, like a dot or a pin, making no use of visual variables for further differentiation in most surveyed cases. In contrast, conventional map symbols often consist of multiple information layers (complex symbols), each of them decoded in an associated map legend. The target of complex symbols is to provide an abundance of information, represented through a combination of multiple visual variables (MACEachren 2004) from which the recipient can extract individually relevant parts. In terms of web generations, traditional map symbology would parallel the Web 1.0 concept of catalogues (cf. O’Reilly 2007). In contrast GeoWeb 2.0 platforms offer initial search or filter options which allow users to define the thematic and spatial range of their queries, leading to potentially interesting results. Depending on the overall concept of the platform, they are presented either as textual lists or in combination with maps. Additional to the localization of requested entities, transactional map symbols offer a nearly unlimited amount of additional information, following the mashup concept which is a typical element of the Web 2.0.
Fig. 3: Symbol-inherent information extent: initial determination of content in a GeoWeb 2.0 context (top) vs. decoding of symbols with a corresponding legend (bottom).

As long as users exactly know and determine what they are looking for, unique symbols seem to be sufficient and a further graphical differentiation is more or less dispensable. Detailed information is communicated in a consecutive step of clicking a transactional map symbol anyway. However, it is worth considering if a further visual differentiation of symbols could be beneficial in cases of thematic vagueness or in communicating alternative results. Referring to figure 3 this would mean to apply symbols which are conceptually located somewhere between the two illustrated examples.

The following example describes one of the few cases where multiple visual variables are already applied to transactional map symbols: A web platform provides freely available directory searches and visualizes search results in an overview map. Any information related to resulting entries is located and connected by a transactional map symbol. The service is financed by commercial ads which in turn are higher rated and displayed more prominent than conventional entries. In this sense, visual prominence is auctioned. Analogous business models can be found behind real estate platforms\(^9\), yellow pages\(^{10}\) or city guides\(^{11}\). To which extent this approach can be facilitated on a more general design level is discussed in the last section.

As it becomes clear from the example above the interactive, location-based character of the GeoWeb 2.0 offers attractive, commercial opportunities. They range from simple context-oriented adverts to sponsored location-based content that is displayed in combination with other results on the map to marketing business models that focus on the conversion of the map use to the consumption of a local service (FISCHER 2009). Reviewing various portals reveals great potentials for cartographic improvements of results in order to optimize the revenue of commercial ads. Cartographic research in combination with usability studies could help to utilize graphical effects and visual variables in a more effective way.

\(^9\) http://www.nestoria.co.uk/covent-garden/property/buy# [13.01.2011]
Besides content related aspects in the design of transactional map symbols, the technical framework is of equal importance. Above all, the design of transactional symbols depends on the display resolution and typical map dimensions. In the case of embedded maps, the map object size is decisive. Low resolution or small displays require very simple and unambiguous map symbols. Since the attractiveness and usability of map applications are of major interest, it is crucial to keep every single symbol selectable with any device (e.g. mouse, touchscreen).

In most GeoWeb applications the base map exhibits a high degree of generalization due to potentially small displays and/or low resolution. A clear cartographic hierarchy can be observed. The map itself serves as background for the actual content represented by transactional map symbols. In contrast to symbols within the base map, transactional symbols do not change their size according to the scale or zoom level but retain as initially fixed. Additional visual elements like shadows ensure a clear visual distinction from the base map.

If too many locations or objects meet the initial search criterion, in most cases a selection algorithm is applied in order to prevent the map from a visual overload. Depending on the purpose of the map and the business models (cf. HEPP 2004), different approaches can be observed:

a) Sampling:
   The selection of a delimited number of symbols is regulated by ratings, relevance, popularity, spatial distribution or commercial interests (ads purchase)\(^\text{12}\).

b) Clustering:
   Several nearby locations are represented by one single symbol on a higher zoom level. Mostly this is denoted by annotations or visual effects\(^\text{13}\).

In some cases all database entries are mapped despite overlaps in order to communicate the density of relevant locations, objects or incidences. In this case the principle of individually selectable symbols is violated, but additional information – comparable to dot density maps – is communicated. Most often this method is applied following commercial or political intentions (e.g. Crime Mapping\(^\text{14}\)).

The extensive dissociation of symbol size and scale/zoom level and different approaches for selection (in cartographic terms “generalization”) indicate the discussed shift from a pure cartographic paradigm to a more general framework of geocommunication, dealing with specific, user requested information. Consequently a map generated for a specific request like “Where are the best rated Chinese restaurants in town?”, cannot be used for related questions like “Where are the best rated Italian restaurants in town?” anymore.


\(^{13}\) http://vfdemo.idvsolutions.com/piracy/ [13.01.2011]

4 Discussion and Outlook

The shift from traditional cartography to geomedia design (Brodersen 2008) is widely recognized and accepted (Hruby & Guerrero 2008). However, many of the examples cited in this paper already foreshadow the next step towards a geo-interaction design. Driven by technical dynamics, the abundance of digital data and the high degree of acceptance of digital maps as an interface to the real world, a vast number of new map applications are popping up within all kinds of contexts. Hereby the Web 2.0 provides the groundwork for a broader participation in the cartographic process (Glasze 2009, Frye 2009).

The rapid change in the production and usage of maps and the emerging of transactional map symbols as a new category of map symbols lead to the challenge for cartography to adapt guidelines to a wider conceptual context of map application. Vice versa platform and interface design might gain from cartographic expertise. In recent years new cartographic forms of presentation have been introduced, that refer to restricted and small screen displays of mobile internet applications such as the focus map (Klippel & Richter 2004: 41) or the concept of context-adapted geovisualization (Reichenbacher 2003) that accounts for various output devices and different users in different situations. However a clearly observable lack of research backed guidance leads to the current situation, where the design of GeoGUIs and the related symbology seems foremost determined by web map API defaults or in the best case it is adapted by a trial and error approach based on the observation of user and technology acceptance, as it has become apparent for example in dialogues between community managers and users of the platform Qype. Therefore it seems to be evident, that the potentially positive impact of guideline-based cartographic practice in the design of transactional map symbols should be examined in depth.

As already lined out, this paper shall serve as a discussion input for the establishment of cartographic guidelines and related research for transactional map symbols. Hence, the main application contexts of these symbols were examined and aspects affecting their design were discussed. In the following, the resulting key findings are concluded. Notably these findings are based on an inductive description of the current practice combined with reasoning about influencing side conditions:

- Transactional map symbols are based on point geometries, due to individual selection needs.
- Symbols commonly show a simple, decisive graphical design.
- Most often unique symbols without any further graphical differentiation are utilized.
- Overlapping or very dense point symbols are often avoided through selection or symbol clustering. The selection technique used often depends on the business model of the provider.
- Symbol size is constant and independent from scale or zoom level.
- Symbols are located at the highest visual level within the map to underline their interactive properties. Their prominent foreground position is even more accentuated through visual effects like shadows.

Beyond that, the examination of numerous platforms revealed that the digital map itself is only one component of a broader application with various representations of geographic information. Those representations might include tabular listings of places as well as very
specific descriptions and ratings of place-based objects. To which extent communication and interaction is facilitated strongly depends on the concept of the platform.

Within this broader framework, transactional map symbols are not only a mapped set of user selections retrieved from a database, but take over the role of switching points within a mesh of different views. Therefore they must be seen not only from a pure cartographic perspective but as a core part of a geographic user interface. Consequently general usability issues for GUIs need to be considered, such as “make the user feel control”, “reduce short term memory load”, “strive for universal usability” and “avoid distraction from the user’s primary goal” (WARDLAW 2010: 195). Although some of those aims align well with traditional cartographic design rules, research perspectives for transactional map symbols need to consider a wider context in order to optimize not only the map as such but an integrated geospatial interaction design. When attempting to set up a research agenda in this field, research on different levels of abstraction seem to be promising:

- Although first research activities are reported (e.g. CHOI et al. 2010), research on the usability of transactional symbols on various devices should be conducted. Virtually no study result is available about the mean dwell time on websites with maps or to what extent maps influence the dwell time. This would facilitate important insights, affecting the graphical and functional design significantly.

- Currently, a visual differentiation of transactional map symbols is hardly utilized, limited to highlighting commercial entries. As described, the usage of unique symbols can be justified by initial search or filter operations, precisely defining the objects and locations of interest. As a related advantage – especially in case of applications primarily designed for mobile devices with small displays – unique symbols require no legend. However, in some of the applications examined, the usage of unique symbols seems to be rather based on blind reproduction of similar applications and the tendency to use map API defaults. From the authors point of view it seems to be questionable, if the binary character of unique transactional map symbols is optimal for each and every context. A carefully considered visual encoding of an important attribute might deliver valuable additional information right within the map. For example, instead of giving a choice to display the locations of top rated Chinese restaurants, rated by at least 20 users (and probably receive very few results), the reliability of results could be encoded in terms of symbol transparency as well. Further categorical differentiation (for example using different colour hue for other types of restaurants) could be useful for users who are interested in alternatives to their initial preference (similar to Amazon’s recommendations based on buyers’ preferences). However, to find adequate degrees of symbol differentiation for various contexts and communities needs to be examined.

- As indicated in this paper the intentions of users and providers play a crucial role regarding design aspects for transactional map symbols. Experiences and intentions of portal providers are as essential as the appropriation of location-based content by the users. Research questions within this domain can address the impact of explicit designation of paid content, the usability of different sampling or symbol clustering techniques and benefits as well as limitations related to the commercialization of user attention for marketing business models.

- Related to a broader, more theoretical point of view, existing context-oriented approaches primarily focus on situation, user, activity, information and technology (REICHENBACHER 2003) and rely on a rather linear map communication model (GRYL et al. 2010). This view is too limited since geomedia can be considered as cultural objects
that emerge from the everyday practices of their users and producers (Hepp 2004), rather than being pure sender-recipient relationship (Faby 2009). Hence, research towards an examination of the quotidian contexts of the making and the interpretative adoption of geomedia of a general public is necessary. Through the scientific examination of those modes of appropriation the intentions of users and providers of geomedia will become clear (Fischer 2011). This research perspective on geographic information media can inform design considerations about further visual encoding and categorical differentiation as well as the selection techniques for advanced business models.

References


