reviewed paper

A Digital Platform for the Monitoring of HCB based upon the Reflections of its Conservation Practice in China

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1 ABSTRACT

The Historic and Cultural Block (HCB) is a national designation for the conservation of settlement heritage in China, where groups of significant historic buildings have been preserved within their fabric. Recent years, with rapid urbanization and development, there has been a great threat to various historic centers all around the country. Throughout conservation practice in the past 20 years, there have been three major issues in the information collection, storage and daily management: (1) poor datamation and standardization of information collection; (2) inefficient supervision and management mechanism; and (3) lack of dissemination and communication channels, therefore, insufficient public participation.

In order to improve the conservation of HCB, a pilot monitoring platform is proposed in this paper, which is based on the WebGIS technology. This platform digitally monitors and manages the object with a standardized information system. Data captured from site survey can be used to support analysis, planning, decision-making and management in a visualized, dynamic and cost-efficient manner. Besides, potential functions andapplications are discussed.

2 THE DEVELOPMENT OF CONSERVATION OF HCB IN CHINA

2.1 Origin of conservation system

The conservation of HCB originated from archaeological research in the 1920s in China. In the 60s, the Chinese cultural relic preservation system has been formed. However, until the early 80s, the mainstream of settlement heritage conservation was limited to cultural relics and sites alone, lacking the understanding of overall and systematic preservation measures. In 1982, the first batch of 24 national historic and cultural cities, including Beijing and Nanjing, was released by the government, marking the birth of the historic settlement conservation system, represented by the designation of "National Historical and Cultural City". In June 1996, the historic block conservation symposium was held in the city of Huangshan, Anhui, and in August 1997, the Ministry of Construction (Ministry of Housing and Urban-Rural Development from 2008) issued the “The Interim Conservation Management Measures of Tunxi HCB in Huangshan”, which marked the foundation of Chinese HCB conservation system.[1]

2.2 Status of conservation

The title of “Historic and Cultural Block”, which is approved by the government of provincial level, requires extremely abundant cultural relics and concentrated historic buildings that could completely and truly embody the traditional pattern and historical features in an area of a certain scale. In China, those blocks are significant in the conservation system of settlement heritage.[2] According to the “Regulation of conservation for historic and cultural city, town and village”, cities, to be qualified as “Historic and Cultural City”, should possess more than two HCBs. As a result, the HCB has always been the core of the conservation of historic and cultural city.

In recent years, with China's high-speed urbanization process, the conservation of settlement heritage has been facing great threat, and many HCBs have been severely disrupted throughout the country. In May 2011, the nationwide inspection, launched by the Ministry of Housing and Urban-Rural Development, revealed that there were 13 Historic and Cultural Cities having no HCB, and other 18 cities retaining 1 HCB only. Thus, the situation of conservation for HCBs is highly grim.

[1] WANG Jinghui, On the Different Levels of Historic and Cultural Relic Conservation, In: Proceedings of the 2001 Annual National Planning Conference, 2001
[2] State Regulation of the Conservation for Historic and Cultural City, Town and Village, State Council Decree 524, 2008

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This situation is caused by many factors which could be summarized objectively and subjectively. Objectively, HCBs are always located in the center old town, where, for one thing, the land price could be relatively high, with potential appreciation; and, for another, buildings there are old, mixed, disordered and of high density, where infrastructure is poor that many blocks have become literally "slum" or "shanty towns". In such a complex case, with improper reconstructions, it is likely to cause irreparable damage. Subjectively, the conservation supervising system of HCB is still defective.[3]

3 PROBLEMS OF INFORMATION COLLECTION, MANAGEMENT AND DYNAMIC SUPERVISION

3.1 Poor datamation and standardization of information collection

According to the traditional workflow, information collection of HCB is mainly composed of two phases, field work and office work. Field work is based on the papery topographic map, to evaluate the style, quality and age of architecture, and to document the location and status of each kind of cultural heritage, while at the same time photographing the identified historic buildings. Office work processes the assessment information and photos, generate building evaluation CAD drawings, nevertheless, by means of checking inventory numbers, forming a Word or paper file of cultural heritage that need to focus on.

There are three main disadvantages of the traditional information collection workflow:

3.1.1 Cumbersome and inefficient

Since only paper document is available during field work, large amounts of data sorting and matching treatment are required to be manually input later.

3.1.2 High data error rate

Manual identification of paper drawing, document and photograph need to be checked and matched artificially, which is prone to data errors. On the other hand, evaluation of collected field information is based on individuals rather than a unified standard. Moreover, lack of convenient photograph query system, data error is difficult to find and correct.

3.1.3 Narrow information application scope

Independent paper document not only limits the sharing of information, but also restricts further work such as data analysis, dynamic assessment and so on.

3.2 Inefficient supervision and management mechanism

Due to the isolated paper files or CAD drawings, rather than a unified database, it is difficult for precise spatial query of each building's original status and planning control requirements in the planning implementation and supervision phases. The absence of long-term dynamic monitoring and digital construction project approval system seriously affects the efficiency and effectiveness of the management of HCBs.

3.3 Lack of announcement and communication channel, insufficient public participation

Due to the lack of dissemination and communication channel, data tend to be only available for the urban planning department and design institutions while developing conservation plans. Even after the plan was substantially completed, a small amount of content is published on paper document or web site in the required publicizing phase. In the follow-up implementation process, the measures for public participation are relatively inadequate.

3.4 The goal of the Historic and Cultural Block Supervising Platform (HCBSP)

In order to improve the information collection, dynamic monitoring, elaborating management and such issues, the Historic and Cultural City Institute (Beijing Tsinghua Tongheng Urban Plan &Design Institute) and the School of Architecture (Tsinghua University) initiated the establishment of HCBSP in 2010.

[3] LIU Yecheng, The Challenge and Opportunity of Settlement Heritage Conservation, World Heritages, 2014 vol.6

Based on the fundamental data acquired during both field and office work, the platform is heading towards comprehensive informationization. Besides, the Platform provides different authorization accesses for users according to their professional background and permissions, therefore providing personalized/custom services. By insuring the sustainable monitoring mechanism, the Platform achieves a kind of management which is focusing on unity, real-time operation and economically efficiency.

4 FRAMEWORK AND WORKFLOW OF HCBSP

This platform consists of the server and mobile terminal. The main functions of mobile terminal are map display, editing and operating, data acquisition, editing and inquiry, GPS positioning, thematic drawing display, etc. The server-side handles data pre-processing and post-processing, drawing setup and output, data storage and dissemination, data inquiry and analysis, digital approval, etc.

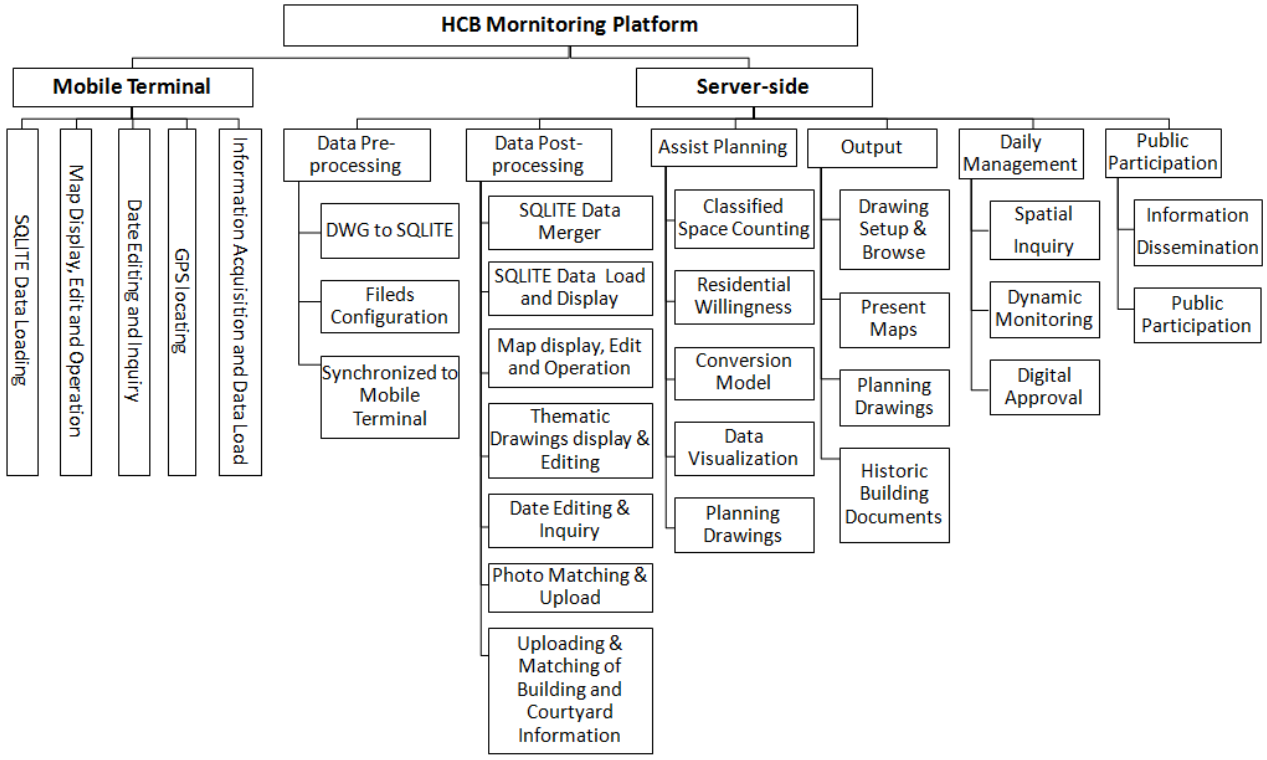

Fig 1: Framework and Functions of HCB Monitoring Platform

Based on the platform, the information collection process of HCB can be divided into five stages:

(1) Convert the original CAD map file into ArcGIS SHP file in servers;

(2) Convert the SHP file into SQLITE database and PNG background file in servers;

(3) Download the processed data to mobile terminals, which are distributed to each survey team;

(4) Each team input information unto mobile terminals and servers are updated;

(5) The data, including SQLITE database, MOV, MP3 and JPG format files, are processed and integrated to form a comprehensive database on the server.

Based on the platform, the conservation planning process can be modified into two stages:

(1) Integrating the comprehensive database, formed after the information acquisition process, with conversion intents form local residents and economic statistics, and taking full advantages of the space and cost analysis tools, administrators and planners are able to make planning decisions efficiently.

(2) On the platform, administrators and planners are also able to deal with preservation zoning decision and block conservation strategy, and thematic maps of present condition, conservation planning and historic architecture archives, etc. could be generated conveniently.

Based on the comprehensive information including status quo, preservation requirement and conservation measures, all of which integrates with the GIS database, such work like spatial inquiry, digital project

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approval, information dissemination, public participation, etc. is going to be conducted. Making use of mobile terminals, local surveyors and administrators are able to identify illegal constructions by means of photographs uploaded to servers.

5 FUNCTIONAL MODULES OF HCBSP

5.1 Server-side data pre-processing module

The data Pre-processing module is capable of CAD file conversion, entry field configuration, initial database and export of configuration to mobile terminal.

To initiate this function, click “Pre-processing” on the server software toolbar, a dialogue box will appear which performs conversion of multiple selected map layers of Building, Text, Road, etc., from CAD file to SQLITE database format. During the conversion, users may configure the entry fields, for example, to add a Property Owner field or Ming Dynasty (1368–1644) and Qing Dynasty (1644-1912) to the Built Year field. Moreover, converted SQLite database file can be synchronized to mobile terminal.

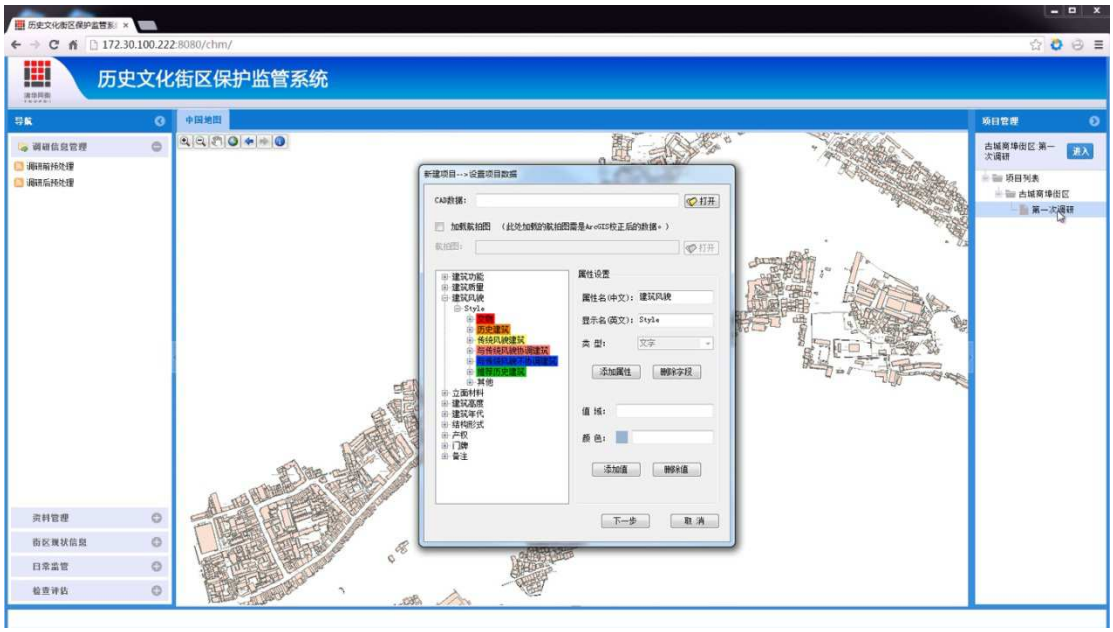

Figure 2, Server-side UI and Data Processing

5.2 Mobile Terminal Module

The mobile terminal software is preliminarily iOS-based and operates on iPad, and the core of which is an independently developed mobile GIS engine with Objective-C language. Here are the main functions:

5.2.1 Map Loading, Displaying and Editing

Pre-processed SQLite database file can be loaded from mobile terminals for actions of Display, Pan, Zoom In/Out on maps. Users can add new buildings or remove existing buildings to update with the latest status, therefore, greatly enhancing heritage information acquisition.

5.2.2 GPS Positioning

The Platform is capable of GPS positioning and itinerary tracing for the information captured in site to be geo-referenced. Meanwhile, GPS tracing can free the surveyor of unnecessary map actions of Pan and Zoom on a small screen, therefore improve the efficiency of field work.

5.2.3 Data Editing and Inquiry

The Inquiry function allows users to input specific information according to pre-processed configurations, and some can have default values. Data input will be transferred into the SQLITE database in a real-time manner to facilitate immediate field-office feedback and interaction. Building blocks with data input are indicated by the color of blue while those without are yellow, which informs the surveyors of the working progress. Tapping the blue block, input data will show up for reviewing or editing.

The old problem of matching photos with respective buildings has been successfully solved in HCBSP by timing. When synchronized with the digital camera, HCBSP will automatically keep track of each group of photos with the set period of Group Photo Time. Later in the office, the EXIF time of photos will be matched with the time of the database automatically, and all the photos are organized into the database according to the object structure.

5.2.4 Data Upload

Data input can be uploaded to server by connecting with the mobile terminal.

Figure 3, Mobile Terminal UI

5.3 Data post-processing module

When field survey is finished, all contents from the SQLITE database is uploaded to server. Post-processing module will merge the discrete SQLITE database to generate a complete database of this HCB. This module contains the following functions:

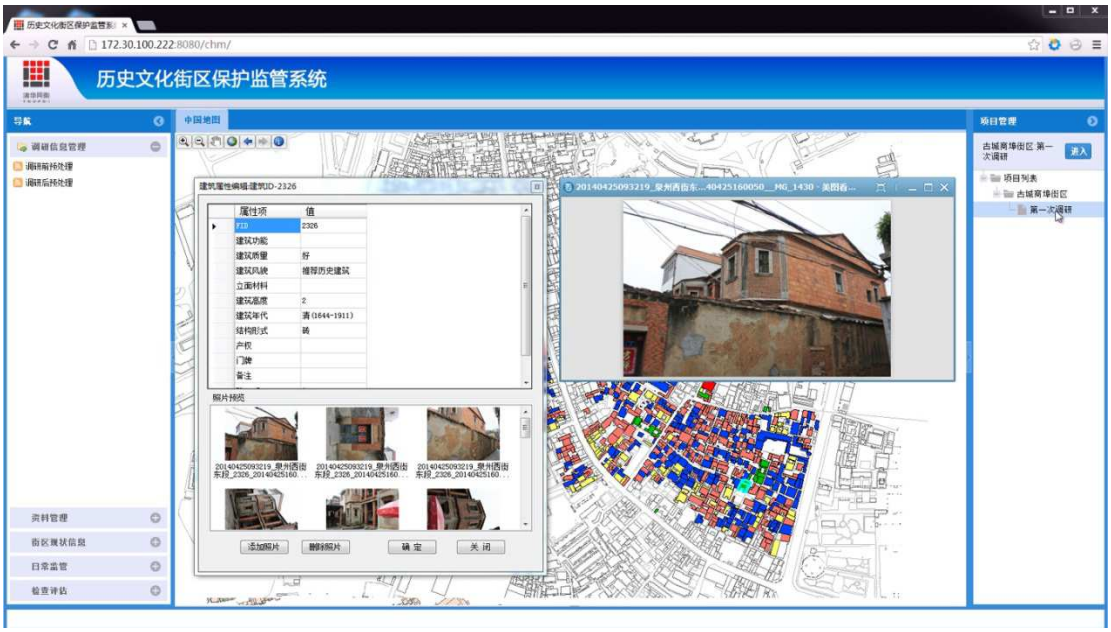

Figure 4, Server-side Post-processing UI

5.3.1 Courtyard Information Import & Matching

Data acquisition of HCB always incorporates three aspects, Building, Courtyard, and Historic Elements. Attributes of Architectural Style, Built Year, Building Quality, Structural Form, and Building Story are associated with Buildings, while those of Address, Ownership/Owner, Use, Occupant, Household, Land Area, Built Area, Heritage Valorization, and Conservation Status are associated with Courtyards. Since those information can be offered by the local government, courtyard boundary and related information can be dealt

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with at Post-process stage. The courtyard boundary can be selected in a CAD file and imported into the database where it is associated with building groups. After the import, information of a specific courtyard can be input and enquired by selecting it first.

5.3.2 Photo Matching & Upload

Photos taken in situ are automatically matched to the corresponding structures according to their EXIF time and loaded to the database.

5.3.3 Database Display& Inquiry

By selecting a Building or Courtyard, a dialog box with related information and photos will display for review or inquiry. Input data can also be cross-checked with photos so surveyors can correct it more conveniently when necessary.

5.4 Assisting Planning & Decision-Making Module

Geo-information analysis and digital mapping modules, integrated in the server, will provide the government agency and professional planners with data of Buildings, Courtyards and other relevant information to assist special analysis and so as to decision-making on a web browser interface.

5.4.1 Conservation Area Designation & Conservation Measures

Acquired data of Architectural Style, Conservation Status, Built Year, and Building Height can be used to analyze the distribution of different types of buildings in HCB. By selecting groups of buildings in an area, a real-time analysis of the proportions of various designation types will be generated, which, combined with the boundaries of both natural features and properties, and the Core Conservation Area and Control Zones are created. This database can also help planners to develop conservation requirements and intervention measures.

5.4.2 Conversion Model & Implementation Sequence

Government agency and planners can get the conversion intents and preferences of local residents by mobile terminals in the first time, and, combining with Built Area and other data in the server, total conversion cost can be calculated, so as to determine the conversion model and implementation sequence.

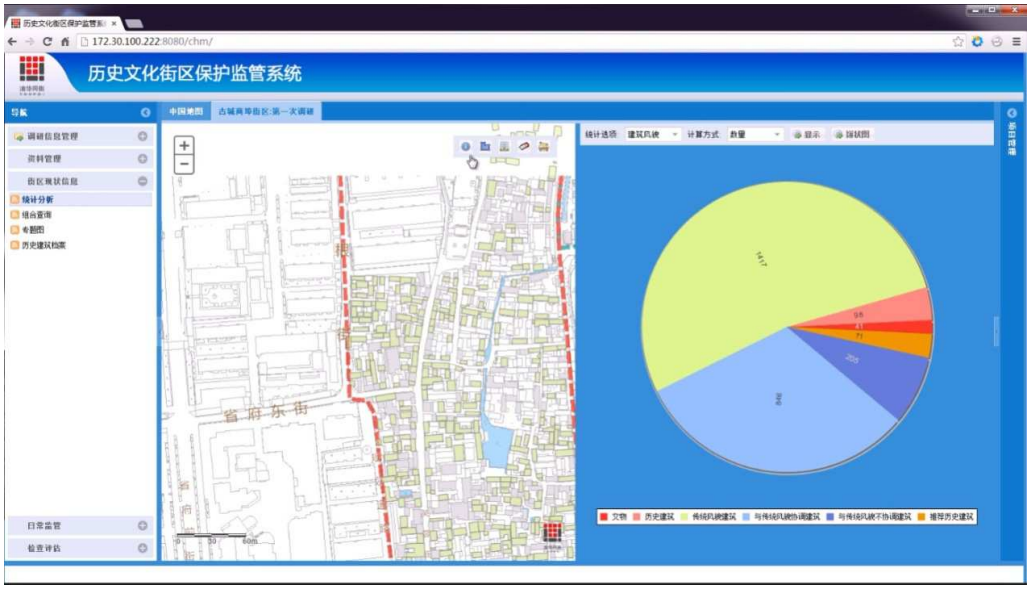

Figure 5, Assisting Planning & Decision-Making UI

5.5 Output Module

5.5.1 Drawing Setup & Output

Thematic drawings are setup with conservation area boundaries, current state and intervention measures, with various overlapping layers of planning information, i.e. Architectural Style, Conservation Status, Built

Year, and Property Ownership. Drawing keys, wind rose, and scales are automatically generated in the CAD or JPG files.

5.5.2 Historic Building Document Output

Documents of buildings with different heritage value ratings, especially historic buildings, are created from a preset document template based on Courtyards with computer generated metadata and details. The output DOC files can be edited whenever update occurs, therefore efficiently building up a comprehensive archive for the future.

Figure 6, Output UI

5.6 Day-to-day Management Module

All related information is stored in the geo-information database which facilitates smart management by means of geo-referenced inquiry, dynamic monitoring and digital approval.

5.6.1 Geo-referenced Inquiry

Traditional archive usually takes the form of isolated textual materials and drawings, while some of which are even paper files only. This is inconvenient for inquiry, reproduction, and dissemination. To overcome such defects, the Platform integrates the current state, plans, and all related information into a single geo-information database. Users with different access authorizations will get corresponding information on the website, therefore greatly enhancing the efficiency of comprehensive and geo-referenced inquiries.

5.6.2 Dynamic Monitoring

Local surveyor and management staff, by means of a friendly UI on the tablet, can effectively document the Buildings, Courtyards, and Streets by means of photograph as well as audio/video recordings. These multimedia files can be associated with heritage information and then uploaded to the server to inform local management.

5.6.3 Digital Approval

Based on the acquired information of the conservation status and established planning criteria, stored in servers, project approval matrix will be automatically generated to inform administration.

5.7 Dissemination & Public Participation Module

5.7.1 Dissemination

General information about the sector and significant updates of the planning process are publicized on the website, to support the dissemination of the historic and cultural values, conservation status, planning

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progress and approval result, which will improve the understanding between the public, the professional, and the authority.

5.7.2 Public Participation

Public opinions are collected, whether at the website or from a mobile App on a smart phone or tablet, so that the general public can participate in conservation. Photos of the streetscape taken by the public can also be uploaded into HCBSP to monitor the conservation status.

6 TECHNICAL INNOVATION &PROSPECTION

HCBSP is the first to incorporate mobile GIS technology into the practical field of human settlement heritage conservation in China. Integrated process of historic sector data acquisition, conservation planning and monitoring has given rise to effective real-time information acquisition and management as well as smart conservation planning and monitoring. Preset interfaces can be used for various forms of historic and cultural presentation by means of 3D point cloud-based models, holograms, and historic and cultural interpretations, providing comprehensive professional cultural heritage user experiences. HCBSP is to become the leading integrated solution of the conservation, interpretation, presentation and management of historic sectors for a greater audience in the future.

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