



# Research Competence in Planning, Construction and Operation

**Frankfurt Research Institute for  
Architecture • Civil Engineering • Geomatics**

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# Frankfurt Research Institute for Architecture, Civil Engineering and Geomatics

**The Frankfurt Research Institute for Architecture • Civil Engineering • Geomatics** stands for applied research into sustainable planning and construction in the Frankfurt Rhine-Main area. With its planning- and construction-related disciplines, the Frankfurt Research Institute for Architecture • Civil Engineering • Geomatics holds special social responsibility for sustainable structural development of the urban and rural spaces in this area as well as for the well-being of the people living there. Application-oriented research provides a basis for resource-efficient planning and development combined with the creation of an attractive built environment.

Interdisciplinary research is one of the most important attributes of the team of scientists working together at the Frankfurt Research Institute for Architecture • Civil Engineering • Geomatics. Such cooperation is reflected in the wide range of research areas:

1. Resource efficiency in planning, construction and utilization
2. Renewable energies
3. Sustainable planning regarding towns, countryside, infrastructure and mobility
4. Data management in planning and construction
5. Interdisciplinary approaches to design, planning and utilization

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# 1. Field of research: Resource efficiency in planning, construction and utilization

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The main emphasis in this field of research is on user comfort, life-cycle, and resource efficiency. Crucial issues are energy efficiency and sustainability with reference to materials, construction and utilization as well as the integration of renewable energies. Aesthetics, functionality and lifespan become intricately merged, a factor which is reflected in product development and maintenance issues in terms of materials, façade and facility technology. Further points of interest are suitability for daily use and actual condition as well as a prognosis with regard to the lifespan of the materials and structural components.

## FOCUS OF RESEARCH: BUILDING MATERIALS AND MATERIALS CONTROL



### Concretes, coatings and measuring techniques

- electro-optical measuring systems for determining roughness parameters in shear joints, adhesion and material requirements with regard to coatings and toppings, skid resistance of pavement surfaces and anti-slip properties of floors
- investigating physical and chemical weathering of concrete with non-contact measuring techniques

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## **New building materials and manufacturing processes**

- “growing” mineral construction components – evaluation of transference potential of technologies used in the creation of artificial coral reefs by means of electrolysis for application in construction processes

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## **Textile materials for lightweight construction and gradient materials**

- lightweight construction with 3D textiles, textile technologies as a basis for new gradient materials and sustainable constructions, development of composite materials, e.g. in combination with spacer fabrics and foam technology
- prizes and exhibitions: prizes for student research projects include “Stuttgarter Leichtbaupreis” (Stuttgart Prize for Lightweight Construction) 2014”, special award for micro-architecture at “Textile Strukturen für neues Bauen (Textile structures for new style construction) 2015”, exhibition with the theme “FabricFoam©” in DETAIL research Lab at BAU 2015 (international trade fair)
- research projects: „3dTEX – Wandelemente aus Abstandstextilien“ (3dTEX – Wall elements and spacer fabrics), see also Focus of research “Renewable energies in architecture”

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## **Building protection systems**

- chemical and physical transport and damage mechanisms in mineral building materials – measurement, modeling and prognosis
- various aspects of building physics in the construction of basements for high-grade use, heat and moisture protection

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## Construction processes in road building

- conducting trials regarding a new process for filling heating pipeline trenches underneath road surfaces
- monitoring and certifying asphalt mixing facilities, conducting trials on conformity processes for CE marking

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## Geotechnics and foundation engineering

- analyzing and modeling the behavior of full-displacement piles through digitization workflow in the laboratory, systemizing the quality inspection of structural behavior in field tests
- bank infiltration – interaction between extremely high tide and groundwater levels in the Frankfurt area and in the model area of Kurozwęki Palace (Poland), developing a comprehensive calibrated groundwater model, analyzing existing protection measures, compiling a catalog of measures

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## Further development of structural frames and façades

- design and further development of structural frames and façades with parametric and generative design strategies with due regard to structural aspects and the requirements of building physics

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# FOCUS OF RESEARCH: SUSTAINABLE PLANNING AND CONSTRUCTION OF BUILDINGS



Photo: M. Schuppich, fotolia

## Intelligent building envelopes

- innovative hybrid façades as intelligent building envelopes

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## Acoustically effective façades

- investigation of urban space in major European cities with regard to architectural situations and resulting acoustic conditions
- creating and optimizing acoustically effective façade surfaces with subsequent evaluation using specially developed acoustic measuring techniques
- “Frankfurter Hochhaus-Fassadentage” (“Frankfurt high-rise Façade Days”): a biannual symposium on glass and façade building

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## **Adaptive sun shading devices**

- design and further development of structural frames and façades with parametric and generative design strategies with due regard to structural aspects and the requirements of building physics
- project: adaptiveness of façades for increasing the amount of daylight in buildings –examining possible use of adaptive sun shading devices for enhancing user comfort in buildings in terms of views outside and intensity of daylight inside while fulfilling the high energy requirements regarding heat protection in the summertime, and the development of generative design strategies

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## **Energy-efficient building technology**

- innovative energy-plus building – low-energy buildings as a minimum standard for new objects
- comfort and user satisfaction – systematic user survey with regard to specific requirements in terms of light, air quality, temperature and acoustics

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- energy refurbishment of residential buildings and non-residential buildings
- innovative energy concepts
- sustainable educational facilities, laboratory buildings, urban quarters

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## Optimizing energy potential in buildings

- optimizing energy potential in buildings and individual well-being through microclimatic influences
- importance of early design in sustainable buildings
- person-building-comfort interface (level of acceptance, user surveys, subjective comfort)
- energy-saving potential and performance enhancement through additional natural light in buildings
- driving factors, level of acceptance and decision criteria in the realization of sustainable projects

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## Sustainability during the life cycle of a building

- ecological audit and life-cycle assessment of materials and buildings
- optimizing environmental effects of buildings throughout the entire life cycle
- use of life-cycle assessment in the early planning phases
- developing more simple presentation of results regarding ecological audits of buildings for evaluating individual planning options

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## Construction management

- developing alternative mechanisms for timely and effective on-site settlement of disputes inherent in construction contracts
- designing construction management studies on innovative construction methods and comparing their pros and cons with conventional methods

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## Sustainable management of existing properties

- user surveys, determination and evaluation of energy and water consumption, cost controlling, process optimization, determination and evaluation of life-cycle costs
- facility management in hospitals
- benchmarking FM processes (consumption and costs), optimizing facility layouts
- computer-aided facility management (CAFM)
- CAD and CAFM interfaces, optimizing data collection, process depiction in CAFM

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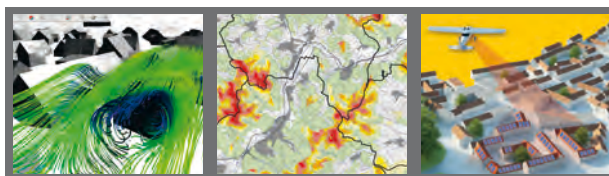
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## 2. Field of research: Renewable energies

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This field of research deals with potentials and technologies relating to renewable energies. It comprises location and potential analyses for various forms of energy, testing and developing of new technologies, study of resource-efficient processes, and design of building materials.

### FOCUS OF RESEARCH: RENEWABLE ENERGIES IN PLANNING AND DESIGNING BUILDINGS AND IN LAND MANAGEMENT



Photos: Martina Klärle, Ute Langedörfer

#### Location and potential analyses

- research project SUN-AREA: developing fully automated solar roof potential cadastres based on laser scanner data
- research project ERNEUERBAR KOMM!: renewable energies for municipalities and rural districts
- research project WIND AREA: GIS-aided location analysis for wind energy facilities
- scientific support for the development of sustainable energy regions, bioenergy regions and renewable energy regions

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## FOCUS OF RESEARCH: RENEWABLE ENERGIES IN ARCHITECTURE



Photo: Thomas Ferwagner, Solartension GmbH

### Innovative materials and high-value construction

- examining, developing and applying intelligent energy-efficient and creative materials and constructions, especially as a combination of energy-active and energy-passive systems in lightweight design
- publications and completed research projects regarding building with semiconductor materials, e.g. integrated photovoltaics: “Architektur unter Strom”, “Energizing Architecture – Design and Photovoltaics”
- research projects including “Energetisch wirksame 3D-Textilien für Fenster und Türöffnungen als solaraktive Sonnen-, Lichtlenk- und Wärmeschutzelemente” (Energy-efficient 3D textiles for windows and doorways – solar active elements, light directing elements and thermal insulation elements), see also focus of research “Building materials and materials control”

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### 3. Field of research: Sustainable planning regarding towns, countryside, infrastructure and mobility

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This field of research offers strategies which are absolutely essential for dealing with the effects of urban growth and demographic change on planning and construction. Besides topics such as fitting out houses and redesigning towns, it also looks at planning a sustainable water supply, managing rain-water and ensuring long-term mobility. Other aspects of research include technical, planning-related, social, demographic and economic challenges and the potential inherent in present-day and future forms of mobility.

#### **FOCUS OF RESEARCH: URBAN PLANNING AND LAND MANAGEMENT**

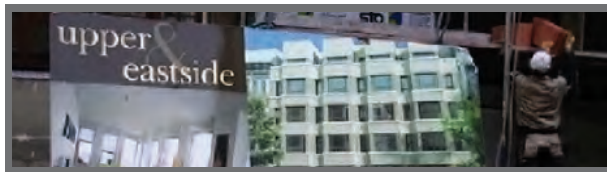


Photo: Michael Peterek

#### **Town planning in urban agglomerations**

- rapid planning – sustainable infrastructure, environment and resources management for highly dynamic metropolises, development of a rapidly implementable, transsectoral urban planning methodology with a focus on basic urban infrastructure, specifically targeting energy and water supply, waste water, solid waste and urban agriculture
- “Centres Beyond the Centre”: study of typologies, functions and spatial structures of contemporary city regions (in cooperation with international partner universities integrated in the master’s degree program entitled “Urban Agglomerations”)

- Stadtteilatlas (district atlas) Ostend, Frankfurt am Main: transformation of an urban district in Frankfurt am Main resulting from conditions of global change and the moving in of the headquarters of the European Central Bank
- urban development and demographic change – challenges and future demands on sustainable urban planning

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- development of urban design and housing in the 1960s and 1970s, with special focus on physical and organizational change, processes of identification and shifts in emphasis; mixed methodology loosely based on the concept of research applied to biographies
- research into gentrification, specifically the exploration of gentrification as a result of cultural and societal processes
- geographical areas: most important ones are London, UK, Netherlands, Balkans

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### **International town planning and urban development**

- evidence of decolonization and recolonization: theoretical research and publication project including the creation of an archive; interpretation of current architectural, spatial, political, cultural and artistic concepts based on previous experience of colonization – geographical focus is Latin America



- landscapes of pressure – Paisajes de Presión: research and photography project arising from the conviction that contemporary politics of land management respond to the logic of the global economy and consequently convert any territory within a metropolitan agglomeration into an object of speculation – special emphasis is placed on Spanish post-crisis landscapes ([www.pressured-landscapes.net](http://www.pressured-landscapes.net))
- patterns of community-building, progressive urbanism and city production from the bottom up: applied comparative project with the aim of observing and evaluating long-term processes of formation and consolidation in informal settlements under specific local and globally changed conditions and incorporating the results into the planning process
- urban memory and creation of local identities in a self-built city in Lima/ Peru: project involving systematic research, documentation, visualization and communication of „unofficial“ collective memories, knowledge of town building, and urban palimpsests in consolidated self-built neighborhoods – this constitutes one of the richest unwritten and non-classified archives of urban and community building

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- SuStaN (Sustainable Starter Neighborhood) – planning guidelines for lower-middle-class neighborhoods in emerging cities of the South; proposed partners: GIZ (German Corporation for International Cooperation), UN-Habitat
- NeoTown Record – database for categorizing privately developed megaprojects in an international context; interface of research and teaching for advanced master's degree students
- Landscape of Surprise International – comparative study of urban typologies in rapidly growing urban peripheries in Africa, Latin America and Asia (based on the project described in [landscapeofsurprise.net](http://landscapeofsurprise.net))

- UVIPS (Urban Violence Prevention Scheme) – guidelines for implementing and spreading the “Violence Prevention through Urban Upgrading Project” in Khayelitsha in Cape Town; proposed partners: German Bank for Reconstruction (KfW), SUN Development Cape Town, City of Cape Town

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### **Global Cities Database**

Study of 25 cities with regard to land use, population, jobs and economic development in the context of their dependency on private motorized transport for the period 2005/06 in comparison with data gathered in 1995/96

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### **International land management and real estate economics**

- property rights, rule of law, land policy, rights of access, rights of ownership
- portfolio and asset management – land as a commodity for poverty reduction
- “Homo Cooperativus” – renaissance of land and producer cooperatives, trusts and foundations for the urban and rural poor
- land market and sustainability within the property valuation process (assessment and appraisal)
- property taxation (e.g. land value tax)

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### **Environmental protection in land-use planning**

- soil protection within the land-use planning process and building permit process
- urban development within the framework of plants producing hazardous material (SEVESO II/III)

- urban life and noise
- renewable energies (wind power/photovoltaics) vs. construction law

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## **Regional land management and rural development**

- sustainable infrastructural development of villages in several federal states, e.g. Baden-Württemberg, Bayern, Rheinland-Pfalz, Hessen
- one municipality, one plan – combining and integrating all municipal spatial planning issues under a single streamlined, flexible management
- integrated rural development – integrating ILEK (Institute for Lightweight Structures and Conceptual Design) guidelines and feasibility studies in rural areas

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## **FOCUS OF RESEARCH: MOBILITY**



Photo: Ulrike Reichhardt

### **New Mobility**

- reorganisation of intraurban traffic
- analyses of target groups and locations with regards to electro mobility service innovations
- carrying out basic research into existing mobility innovations in terms of user satisfaction
- carrying out research into acceptance of electromobility in the model region Rhine-Main
- identifying approaches for sustainable implementation of electromobility in everyday traffic

- analyzing potential concerning the creation of residential structures in accordance with electromobility
- establishing a data pool with reference to mobility behavior in different spatial areas
- analyzing event traffic

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- determining consequences of demographic change on public transport
- designing public transport according to user needs

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- motorised private transport in towns – measures for reducing emissions
- traffic-related need for urban motorways

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## FOCUS OF RESEARCH: URBAN WATER MANAGEMENT



### Drinking water supply, wastewater treatment, solid waste management

- sustainable urban water resource management in rapidly developing urban areas
- development of such concepts for emerging economies and developing countries
- impact of demographic change and climate change on residential water management

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### Urban drainage systems

- discharge of pollutants from combined sewer systems into receiving waters with reference to current legal requirements
- development of assessment methods for decentralized treatment of urban runoffs
- development of rainwater treatment devices
- studies in quantity and behavior of solids, heavy metals, and nutrients in runoffs

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## 4. Field of research: Data management in planning and construction

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A reliable system of data management is required for this field of research in order to establish a starting point for design, planning and construction.

With the help of three-dimensional geodata it is possible to carry out analyses and planning in virtual worlds before cost-intensive planning in the real world begins. Thus the data constitute an important factor in the decision-making process with regard to both politics and general planning. Geodetic measurements form the basis of planning, design and utilization.

By means of technical sensors, things which are not visible to the human eye can be visualized. In other words, remote sensing and photogrammetry can provide answers to questions relating to urban development.

# FOCUS OF RESEARCH: GEOGRAPHIC INFORMATION SYSTEMS



Photo: Robert Seuß

## Laboratory for geoinformatics

Research questions and technology transfer in spatial information systems and building information systems

- spatial data infrastructure (SDI)
- 3D geoinformation
- processing strategies for laser scanning
- application and further development of geoinformation in a municipal environment

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**Philipp Winkemann MSc (GIS)**

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## SDI test platform “INSPIRE-kommunal”

- creation of a web-based platform through which it is possible to test SDI-based services and scenarios as well as to implement and present typical operating processes of a municipality, e.g. training and information events for various target audiences
- conceiving and developing the SDI test platform “INSPIRE-kommunal”
- adapting viable data-capture methods for communal geographic information systems

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## GDI-DE registry

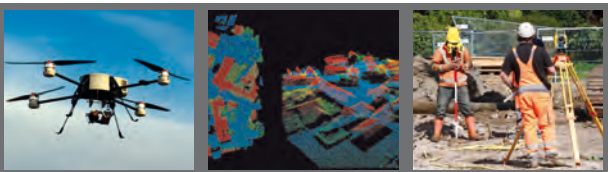
- designing and developing a registry platform for spatial data infrastructure in Germany (SDI Germany)
- providing registry data models compliant with ISO 19100 standards
- developing OGC-compliant web services infrastructure
- implementing registry data models and procedures for organizations, code-lists, namespaces and INSPIRE-based monitoring

## GIS-based location analysis in retailing

- installing a nationwide database for retail location in Germany
- developing a retail information system (desktop and web)
- developing and providing local and global market reports

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## FOCUS OF RESEARCH: GEO-DATA ACQUISITION



Photos: Ansgar Greiwe (left and center); Kara, fotolia (right)

## Laboratory for geodetic sensors

- Curve fitting – developing economical methods with the aim of balancing large-scale, high-precision engineering networks for tunnel, rail and bridge construction with the help of sensors



- deformation analysis – improving statistical analysis of object movements using geodetic measurements based on hybrid data

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### **Laboratory for industrial metrology**

- analysis and optimization of processes in large volume metrology (Lasertracker Leica AT401) and industrial metrology
- parameter estimation (network adjustment, regular geometries), application of GUM (Guide to the Expression of Uncertainty in Measurement [DIN V ENV 13005]), and Monte Carlo simulation

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### **Laboratory for photogrammetry and remote sensing**

The laboratory for photogrammetry and remote sensing is equipped with sensors and copters (UAV) for obtaining photogrammetric images of infrastructure objects. A computer cluster and high-performance, partly self-developed software can be used to evaluate the data acquired through remote sensing (UAV, aircraft, satellite).

Research and development activities include:

- monitoring urban biotopes and infrastructure
- capturing 3D images of façades and industrial facilities
- reconstructing building geometries and their photorealistic image

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## 5. Field of research: Interdisciplinary approaches to design, planning and utilization

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The way changes are dealt with has a great impact on the outward appearance of a town and its architecture. Design styles, various concepts and general usage (including vacant properties) all combine to influence the aesthetics of a town. This field of research shows how architecture and urban design create impressions and realities. Design concepts are presented which take into consideration social and cultural aspects on the one hand and the interaction between people, energy and environment in the local and global context on the other hand.

### FOCUS OF RESEARCH: SOCIOLOGICAL APPROACHES



Photo: dp@pic, fotolia

#### Urban and regional sociology

- social structure
- quality of life
- local development planning

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## **Barrier-free and sustainable planning and construction**

- interdisciplinary approach towards developing possible future solutions in barrier-free architecture and universal design; devising new structural, inclusive systems to encounter the ongoing demographic, sociopolitical and economic changes in Europe and the resulting challenges for our architectural environment; creating synergies among various disciplines, e.g. architecture, computer science, product design, social work, health (in cooperation with BaSys – intelligent systems and case management)
- development of design concepts with reference to social and cultural aspects
- integration of energy-efficient strategies in both a local and a global context with regard to the interplay between people, energy and environment. Focus: Sustainable design concepts for Sub-Saharan Africa (in cooperation with the College of Architecture, KNUST, Kumasi, Ghana)

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## **Space-use patterns and indicators, spatial perception and evaluation**

- creative techniques and scientific methods for working with aesthetics and atmosphere in the design process
- semiotics of architecture and semiotics of product design: signs entailing cultural and social meaning and perception, forms of usage and spatial structures
- spatial perception, forms of utilization, and types of space

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## FOCUS OF RESEARCH: CREATIVE APPROACHES



Photo: Wolfgang Rang

### Design strategies

- “mental images” and their materialization in the real world: design seminars on the use of mental images as catalysts for conscious creative decisions

Topics discussed so far include:

- City Building (1996), Arcades (1997), and Rome (2005), all conducted by Prof. Dr. Hajo Neis
- Light (2006), conducted by Prof. Christian Bartenbach
- Bamboo (1996), conducted by Prof. Niels Gutschow and Prof. Ravindra Vasavedal
- Bricks (2008), conducted by Prof. Niels Gutschow

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