MPI Informatics Building Model as Data for Your Research

Vlastimil Havran
Czech Technical University in Prague
Department of Computer Graphics and Interaction (DCGI)
http://dcgi.felk.cvut.cz/~havran

joint work with
Jozef Zajac (MPII, Slovakia)
Jiri Drahokoupil (DCGI)
Hans-Peter Seidel (MPII)

DCGI

max planck institut informatik

Talk Outline

- Introduction
- Motivation
- Related projects
- Input data
- Work progress and problems
- Created data sets and data formats
  (3D geometry, luminaires, surface reflectances,…)
- Model accuracy and level of detail
- Exploitation and algorithmic problems
- Acknowledgements
- Conclusion and future work

Self-introduction

- Adjunct professor, department of computer graphics and interaction in Prague, Czech Republic
- My current research interests: spatial data structures and range searching algorithms in image synthesis, visibility, sampling algorithms, applied Monte Carlo, etc.
- Home page: http://dcgi.felk.cvut.cz/~havran
- PhD in 2001 for topic: ray shooting algorithms
- Visiting MPII between 2001 and 2006 as post-doc and research associate

Where is Czech Republic?

Central Europe

100 km

Saarbrücken

Project Motivation

- Niklaus Wirth's book: Algorithms and Data Structures, 1975
  (download for free at http://www-old.oberon.ethz.ch/WirthPubl/AD.pdf)
- Data are needed for algorithms as they are subject of algorithms they process them. Some research topics are solely dependent on the data.
- There were some 3D data sets in the previous work, but …..

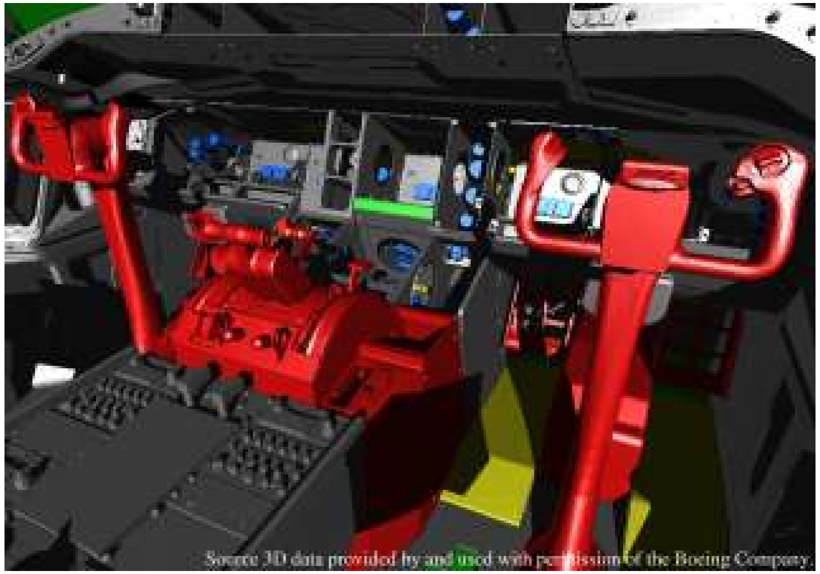


Image courtesy of Wald et al., 2004

Algorithm Performance Dependence on Data

- Size (=number of elements), where element has to be defined in advanced - real numbers sorting in O(N log N)
- Data dimensionality
- Some other known data properties
  - Limited precision or representation - radix sort in O(N)
  - Statistical properties – partially ordered sequences O(?)
  - Information content, entropy,…
  - Others ….
- Coarse research topic classification for algorithms:
  - Easy problems – known worst-case complexities with known practical robust algorithms, wide acceptance in practice.
  - Difficult problems – (un)known complexities, ad-hoc, randomized algorithms.
  - Other difficult problems - known complexities but no practical worst-case algorithms.
- Output sensitive and approximate algorithms – temporary solution?

Reproducibility in Computer Science

- Correctness proof and sufficiently accurate algorithm description, source code, data to allow the verification of results?
- Hypothesis. Publicly available data sets are absolutely crucial to allow the real reproducibility of broad class of algorithms and the validation of their implementations.
- We can merely assume the correct implementation of a published paper - if the results of a re-implemented algorithm are equal with those of formerly published algorithms for the same input data. The algorithm correctness cannot be enforced by using datasets. However, it is really useful to have a reference dataset available for the re-implementation of the algorithm.
- **Interesting note:** J. B. Buckheit and D. L. Donoho, WaveLab and Reproducible Research, Dept. of Statistics, Stanford University, Tech. Rep. 474, 1995.

Reproducibility of Research Work

- Research work has to be reproducible.

- **Wikipedia:** “Reproducibility is one of the main principles of the scientific method, and refers to the ability of a test or experiment to be accurately reproduced, or replicated, by someone else working independently.”

- **Rules of Good Scientific Practice, MPG, 24.November 2000:**

  “The primary test of a scientific result is its reproducibility. The more surprising, but also the more desirable a result is, the more important it is – as far as is possible with justifiable expense or effort – that the route to that result be independently repeated within the research group before the result are passed on to the outside.”

  (Cited text at: http://www.mpg.de/pdf/rulesScientificPract.pdf)

Problems with Datasets in Algorithmic Research

- Some datasets are small (or already obsolete).
- Some datasets have low quality or/and are unrealistic.
- Nice datasets are owned by big customers or individuals and are almost never (99%) released publicly for research.
- Some datasets are partial or incomplete for some purposes.
- Open data format: powerful, flexible, and simple?
- Serious ethic problems using private company data:
  - your research work can be traced and (double blind) review process can be influenced, if you use the data more than once.
  - in 99% cases you can show the images, videos, performance results, but you cannot release the data public for the use by other researchers. Often you cannot use the data after the project with a company is over.
  - the experimental measurements can be reproduced only in theory, but not really in practice by your followers.

#1 Some Datasets already Small or Obsolete.

- Examples:

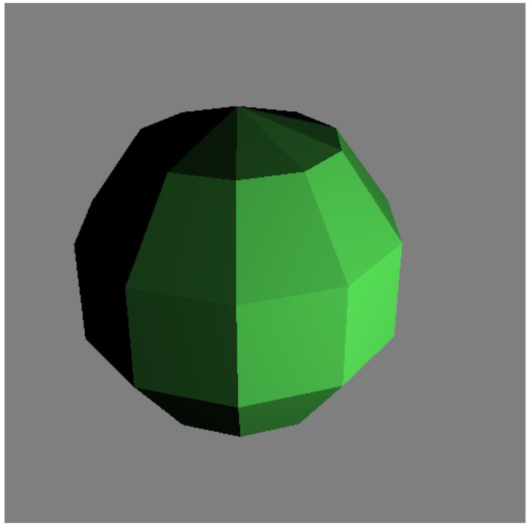
Utah teapot
Year 1975
~ 10,000 triangles,
originally modeled
by Bezier surfaces

? Stanford bunny ?
Year 1993
69,451 triangles
The Stanford 3D Scanning
Repository

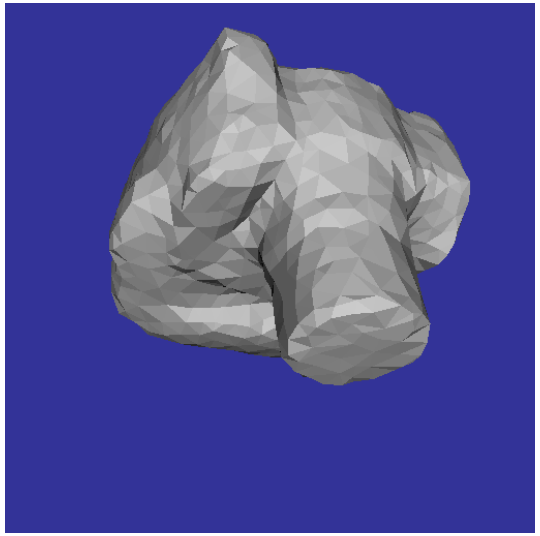
- Nice models anyway, but not really competitive with the real data complexity used in practice in 2009.
- Hypothesis. Each dataset will become obsolete in future (including our project). Sorry for that.

#2 - Low Quality/Unrealistic/Uninteresting/Unconvincing?

73 primitives

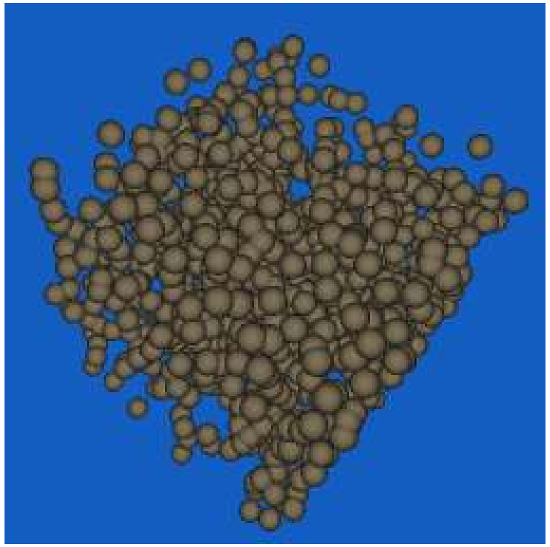


2,324 primitives

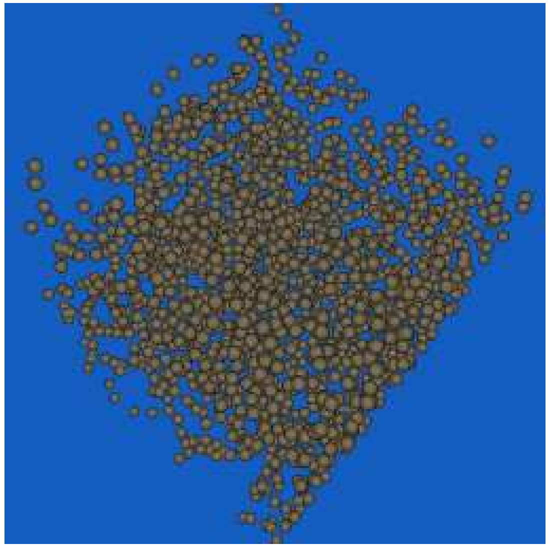


Poisson point process

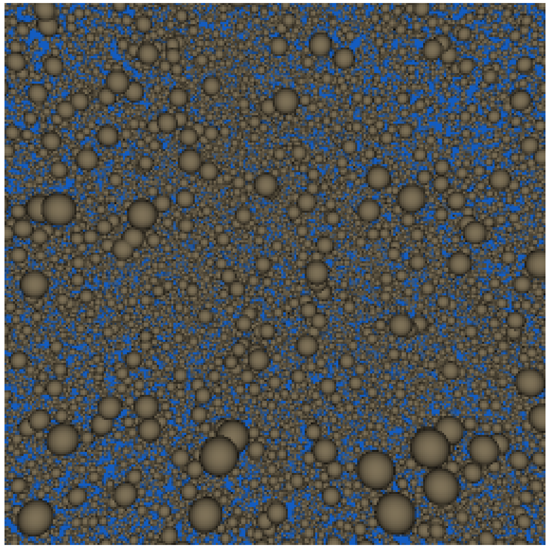
10000 primitives



2,000 primitives

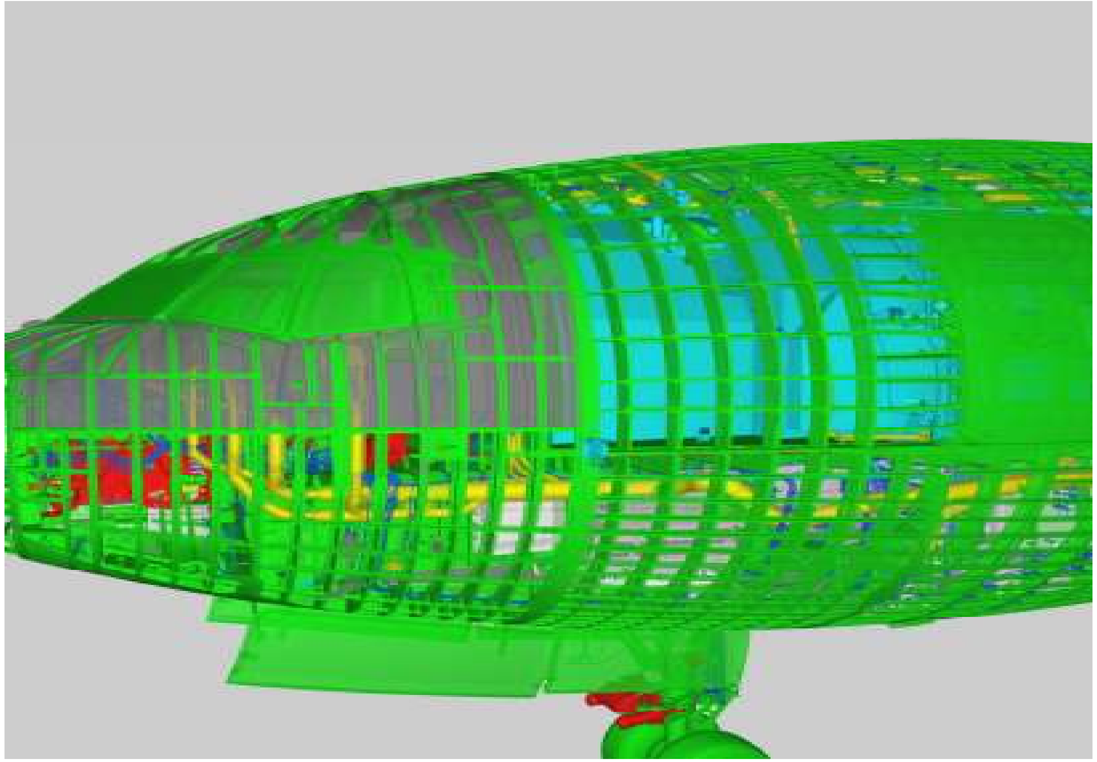


100,000 primitives



#3 - Nice 3D datasets - Rarely Available from a Company

Rare Exception: Boeing model, 350 millions of triangles



However, incomplete model for serious use in **predictive image synthesis:**

- no reflectance data
- no luminaire data
- no acquired reference photographs for controlled outdoor lighting conditions, a difficult access to the airplane.

Some Known 3D Data Sets

- Stanford 3D scanning repository – individual objects, 1993
  - http://graphics.stanford.edu/data/3Dscanrep/
- Soda Hall building model by Prof. Séquin, 1993

  http://www.eecs.berkeley.edu/~sequin/soda/soda.html (558,353 surfaces)
- BES project repository for ray shooting, 1999
  - http://www.cgg.cvut.cz/members/havran/BES/
  - Trial to collect useful 3D datasets on the web
- Sibenik cathedral model and Sponza Atrium model,

  Marko Dabrovic, 2002, http://hdri.cgtechniques.com/~sibenik2/
- AIMshape object repository, 2005
  - http://shapes.aimatshape.net/

RealReflect Project – EU IST project 2002-2005

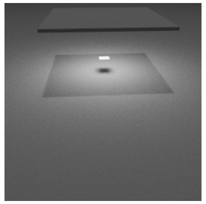
- Predictive image synthesis – the methods to provide as accurate visual appearance as possible.

- 9 project partners from 4 countries.
- Website: http://www.realreflect.org
- Two main application areas:
  - car production - a car model from DaimlerChrysler was available and real world counterpart as well (both after some time).
  - architectural design – PROBLEM ! (VRA company)
- RealReflect project was defended in November 2005 with the mark of excellence.

Validation Methods for Global Illumination Computation
Related Work and Datasets

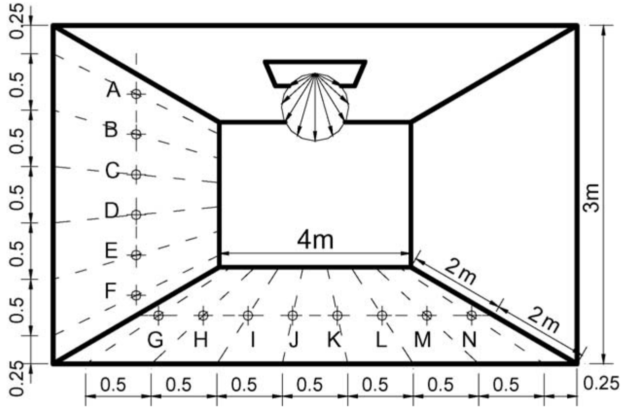
Previous Projects

- *Testing Monte-Carlo Global Illumination Methods with Analytically Computable Scenes*, 2001, Prof. Szirmay-Kalos, Budapest.
- Cornell Box Project, 1998, http://www.graphics.cornell.edu/online/box/
- Drago and Myszkowski's Atrium Project, 1999 (next slide)
- *Global Illumination Test Scenes,* Smits and Wann-Jensen, 2000 http://www2.cs.utah.edu/~bes/papers/scenes/



Parallel Projects

- Roland Schregle PhD Thesis, 2005, Daylight Simulation with Photon Maps
- Ulbricht, Wilkie, Purgathofer: Verification of Physically Based Rendering Algorithms, EG STAR 2005
- Havran, Myszkowski, Wurster, Soler: D10.3 Report on Light Simulation in Architecture, 2005, RR project
- CIE 171:2006 Test Cases to Assess The Accuracy of Lighting Computer Programs



Complex Architectural Dataset for Predictive Rendering

- Aizu Atrium, project by F. Drago and K. Myszkowski, 1999, hosted at MPII http://www.mpi-inf.mpg.de/resources/atrium/

Published as “Validation Proposal for Global Illumination and Rendering Techniques”, journal C&G, 2001

- Subtle or serious problems with AIZU Atrium Model?
  - Is a problem for EU IST project that the building is in Japan?
  - Could be spatial reflectance data (BTF, 7D function) measured additionally?
  - Data were not created in the scope of RR project, is this a problem?
  - Sufficiently complex?Data only for a single hall, no data behind the doors.

RR Project Decision - MPII building ?

- February 2003 - let us try to use AIZU Atrium and also to virtually reconstruct MPII building, it should be possible before the end of RR project or earlier, DXF model exists!
- Some images / video were known to be rendered in the past by architects of the MPII building:

Photo

Rendered image, year ~1993

A Bit of History - MPI Informatics Building

- MPI for Informatics (MPII) was co-founded by Prof. Dr. Kurt Mehlhorn and Prof. Dr. Harald Ganziger in 1990.
- The building of MPII was built between Summer 1993 and Autumn 1995.
- First researchers moved into the building in January 1996.

Project Phase I - Search for Co-workers

- Requirements: proficient in 3D modeling, English knowledge.
- Initial contact during the SCCG conference, April 2003.
- **Jozef Zajac** from Comenius University in Bratislava, Slovakia


– Master student in computer graphics

– teacher of 3D modeling software usage

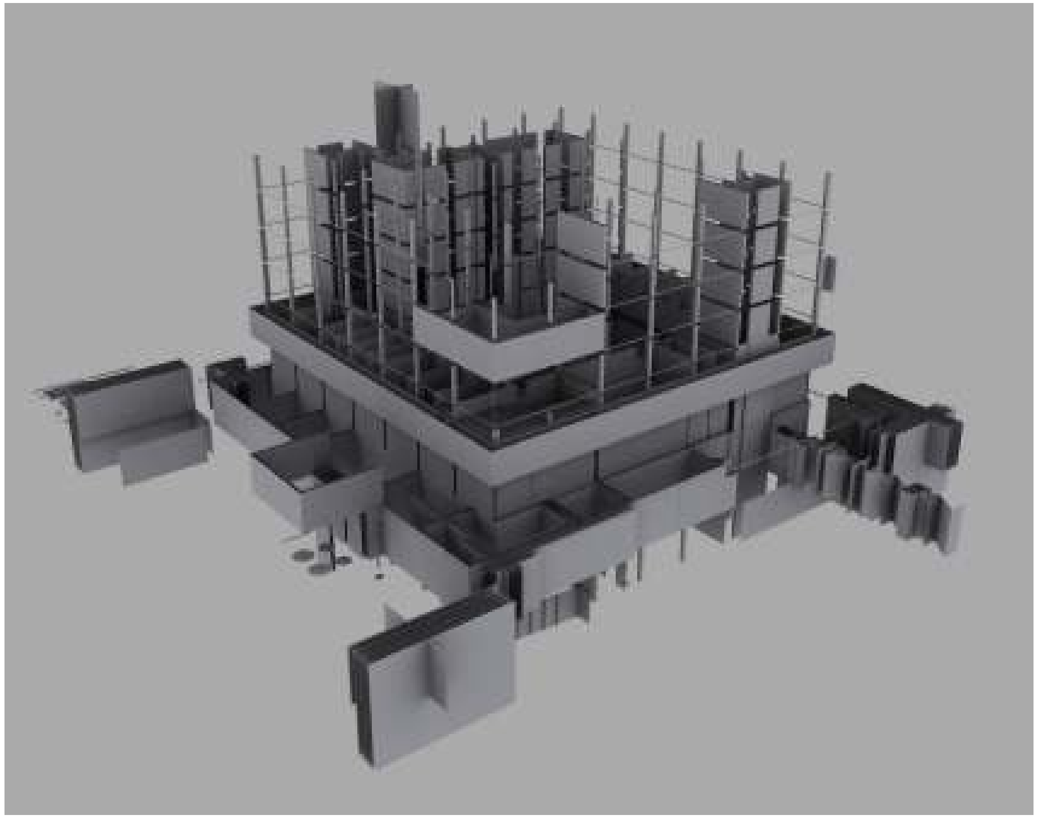
– prepared a major part of 3D model

– was brave to fight the model complexity and problems with modeling software for this size of a project.

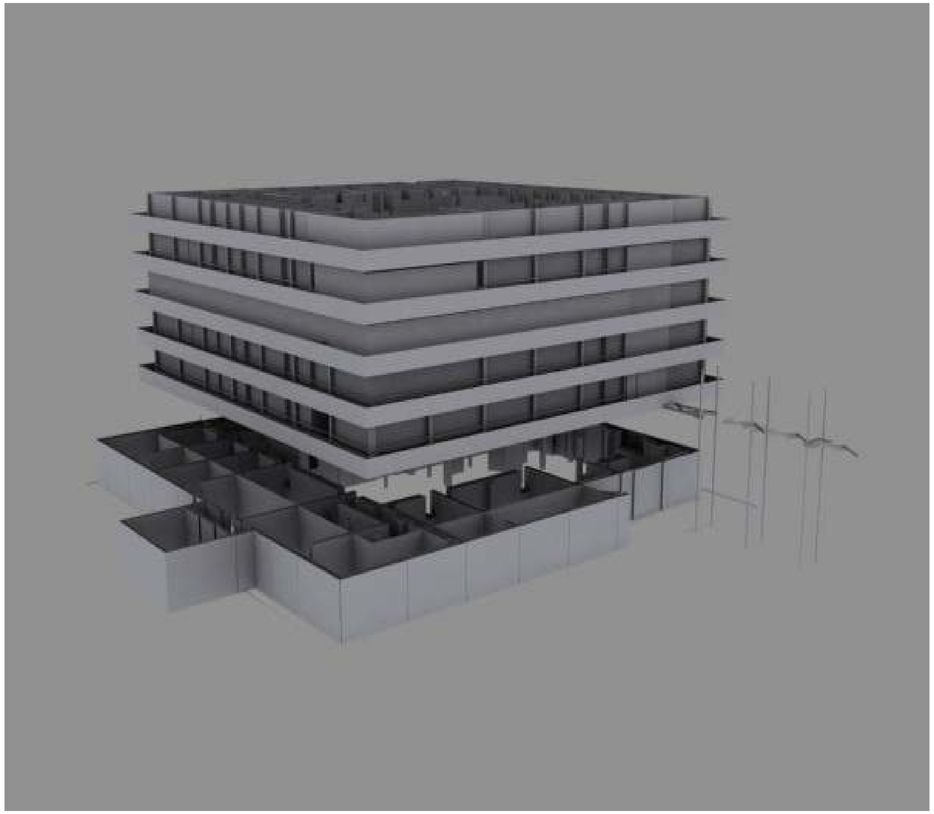
- Several stays at MPII and working at home in the period June 2003 to June 2004. He worked remotely in Slovakia with getting photos and sketches from me in August to November 2004.
- Recently: Josef left the PhD studies in Slovakia, manages a tea-room and the internet tea shop in Slovakia, http://www.teatrade.sk, he still teaches 3D modeling in software packages, but only rarely.

Project Input Data - Geometry

- Two assumptions were wrong:
  - *“3D data in DXF files will be obtained quickly.”* - 6 months
  - *“3D data from architects will be useful.”*
- Software problem – **data migration** from an older software



After the data import

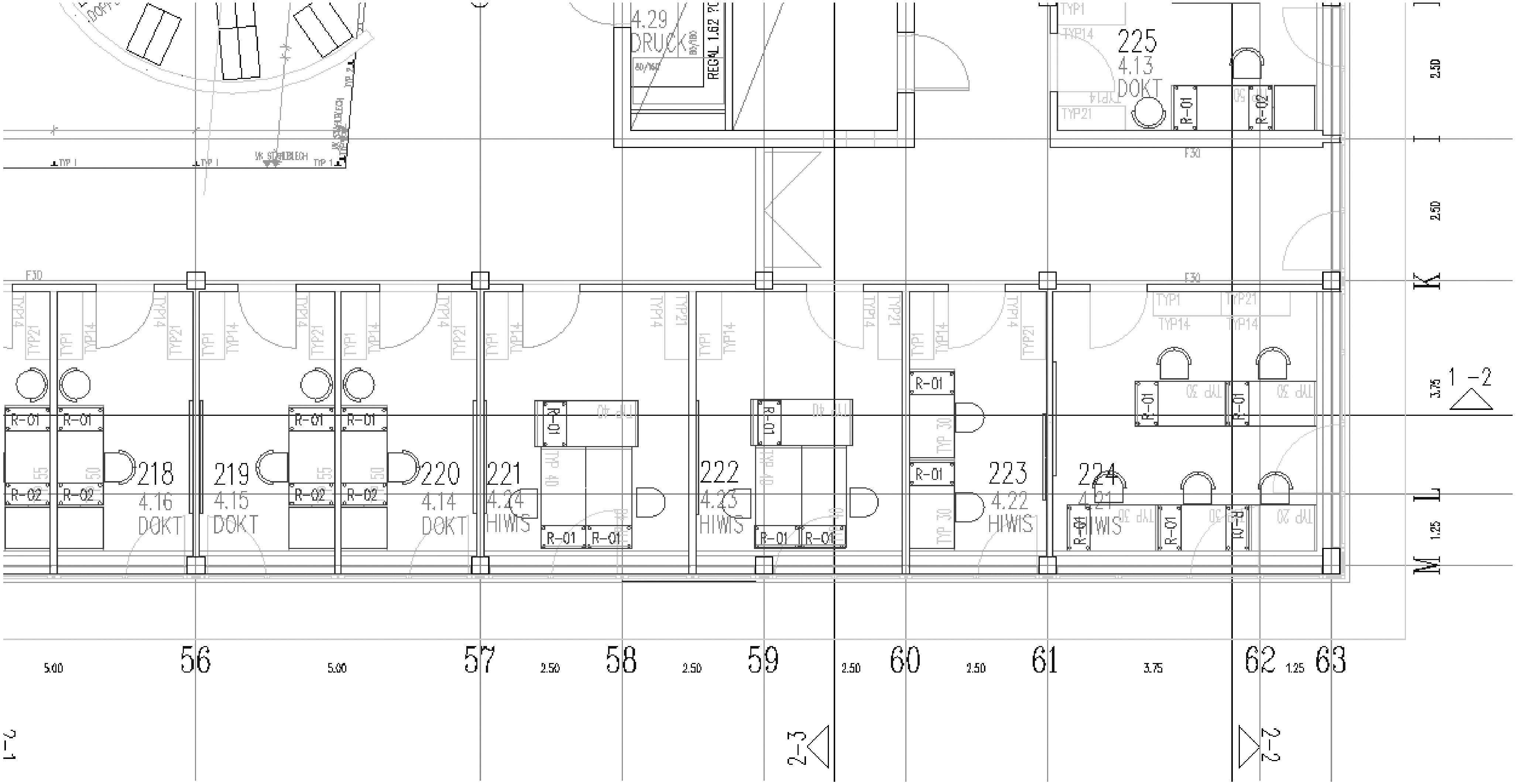


After manual repositioning

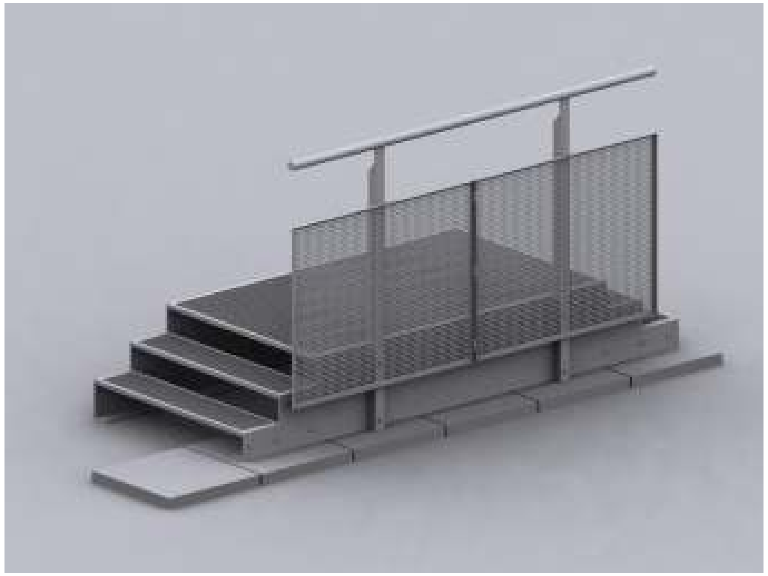
Problems and Data Sources for Geometry Acquisition

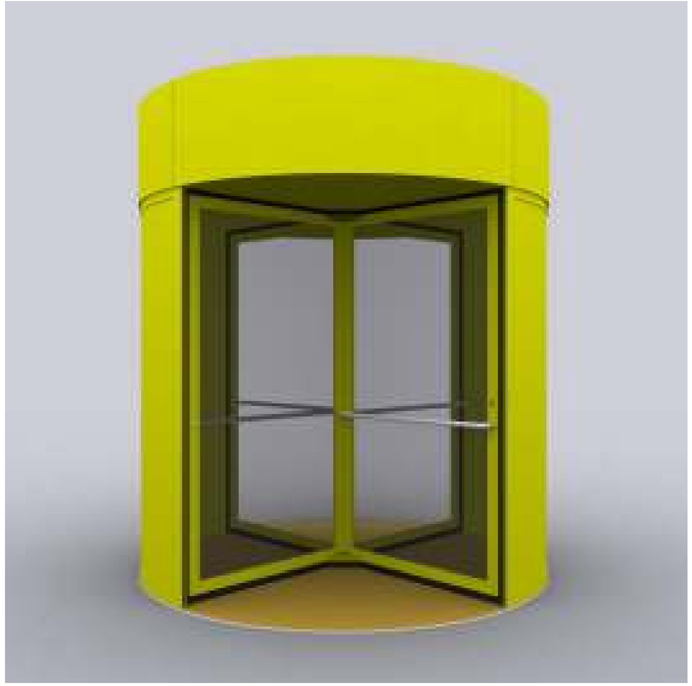
- Data Sources:
  - Copies of technical drawings by architects for all the floors (basic, furniture, and others in format A1 - 594 × 841mm)
  - Sketches and measurements (by meter) of objects and their positions.
  - Photographs inside and outside the building.
- Problems and Solutions
  - Data size solved by decomposition to data subsets (layers) for both modeling and viewing.
  - Rendering of final images was in fact impossible in a commercial software we chosen due to its size in 2004.
  - Time constraints - the part of the project was carried out remotely in Slovakia, my role was to measure and make pictures and sketches of the data etc., Jozef Zajac created new 3D data remotely in Slovakia.
- Major problems
  - Geometric export to open data format VRML97 did not work correctly.
  - The data were not completed by BRDF/Light source acquisition in November 2004.

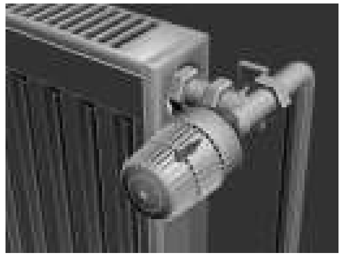
Technical Drawing Example – 2nd floor

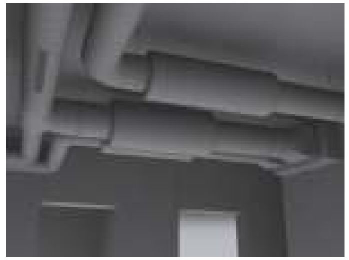


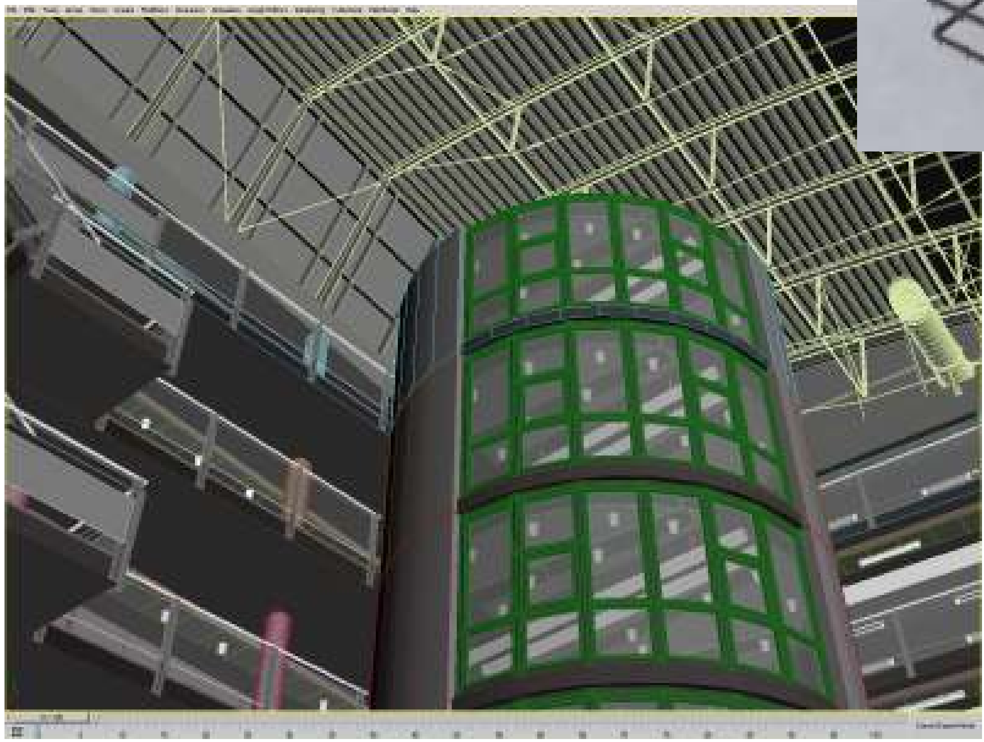
Example Results in November 2004



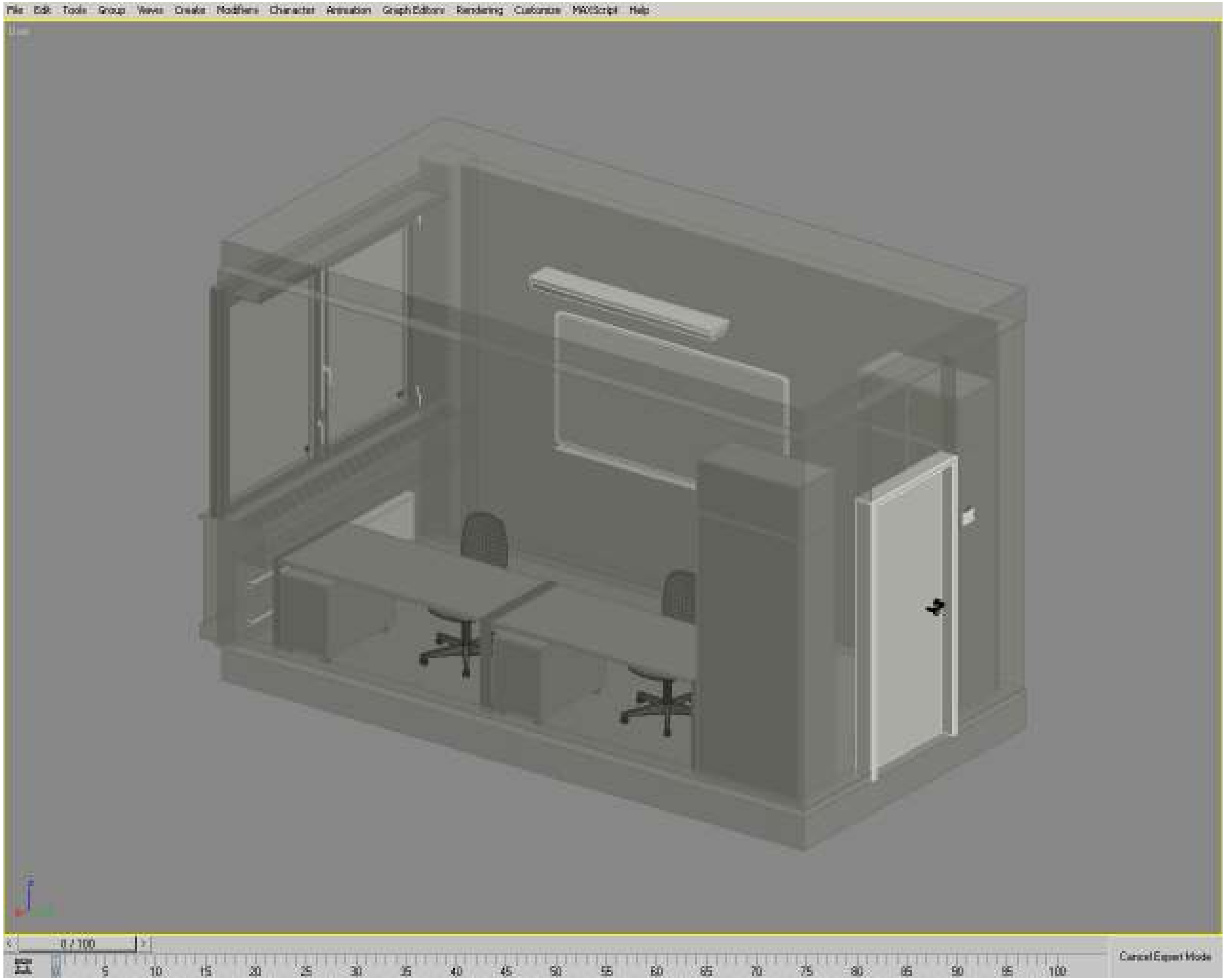








Example Results 2004 contd. – Room 215



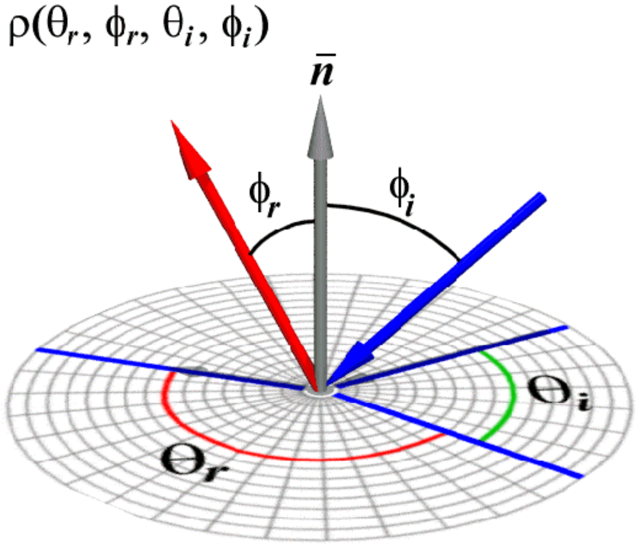
Project Phase 2 - Searching for Solutions and Resources

Crucial decision and general problems in November 2004:

- Some important geometric details needed for visual representation, that would be nice to have, were still missing.
- Data export – write the exporter from 3D commercial software or wait for its newer correct version?
- No reflectance data and luminaries data acquisition – attract the acquisition data group at MPII or buy measurement gantry, or build it myself?
- Measurement gantry – the price in tens of thousands € ?

Introduction to Reflectance (BRDF) Acquisition

- A sample is needed for BRDF measurement, 30x30mm for each material in the building construction …..?!?
- BRDF (bidirectional reflectance distribution function) is a 5-dimensional function, uneasy to measure, represent and use, some efficient data representation is needed.



Note: Spatially varying BTF has 7 dimensions

Gantry for BRDF acquisition Lightec company (France)

Introduction to Luminaire Data Acquisition

- Directional luminous intensity only 2-dimensional function – easier.
- Some data could be available on the web, however,
  in this project the data were not available, should be measured.
- Buying the acquisition gantry seem unrealistic as it is expensive.
- Even buying measurements in Germany was rather expensive….
- Manual measurements were found inaccurate and extremely tedious.

Manual luminaire acquisition test, September 2005

goniophotometer Lightec company (France)

Project Phase 3 – No good solutions – Let us wait

- Date: February 2005
- Lack of resources to complete 3D geometry from RealReflect project and completing reflectance data (buying gantry).
- Wrong 3D data export by commercial software, there were only the two wrong options:
  - Incorrect(=wrong) positioning of geometry.
  - No use of template and instantiation.
- No interest from the data acquisition group for developing and carrying out the suitable methods for this project (preferably avoid extraction of samples) – BRDF and luminaires.

Project Phase 4 – Change for the better in Prague

- Move back to Prague in February 2006
- June 2007 – a student Jiri Drahokoupil got interested in the project in the scope of his Master Thesis:

  "*Predictive Image Synthesis from MPII Building Model*",

  (the text available in Czech only, defended in February 2009)

  – learnt to use 3D modeling software himself

  – completed the 3D geometry to its current state: tens of pieces of furniture, positioning furniture in offices, fences and handrails, etc.

  – measured luminaires and positioned them

  – estimated BRDF for surfaces

  – wrote a data conversion tool to [PBRT / VRML97]

  – initial estimate of camera viewpoints and images

- Jiri Drahokoupil left to the industry in 2009, programming 3D visualization for PDAs, navigation devices, company http://www.dynavix.com/

Phase 4 – Major Problem List Handled

- Software: Not-functional backward compatibility for one software product, different versions of the same product from version 2004 to 2008 - manual correction of 3D data needed.
- BRDF estimation for surfaces at MPII building.
- Luminaire measurements.
- Selection of data formats for the public use:
  - Physically Based Rendering Toolkit (PBRT), book and accompanying software, format description for the software, year 2005.
  - Small extension to VRML 97 format used in the ReaReflect project.
- Missing format description for luminaires in PBRT software (no response from the book authors).
- PBRT crashed when computing the images.
- Conversion data flow design to open formats.

BRDF estimation

- No way to measure the reflectance data with high accuracy
  - Extraction of 53 material samples in the MPII building ?!?
  - Problem to find the same samples without destruction of building.
  - Problem to find a cheap way to measure the reflectance.
- Approximate visual appearance for materials known from the photographs was known.
- MPII visit in March 2008 for 5 days for data acquisition
- BRDF estimated from several other reflectance databases or data found on the web, in particular using the project:

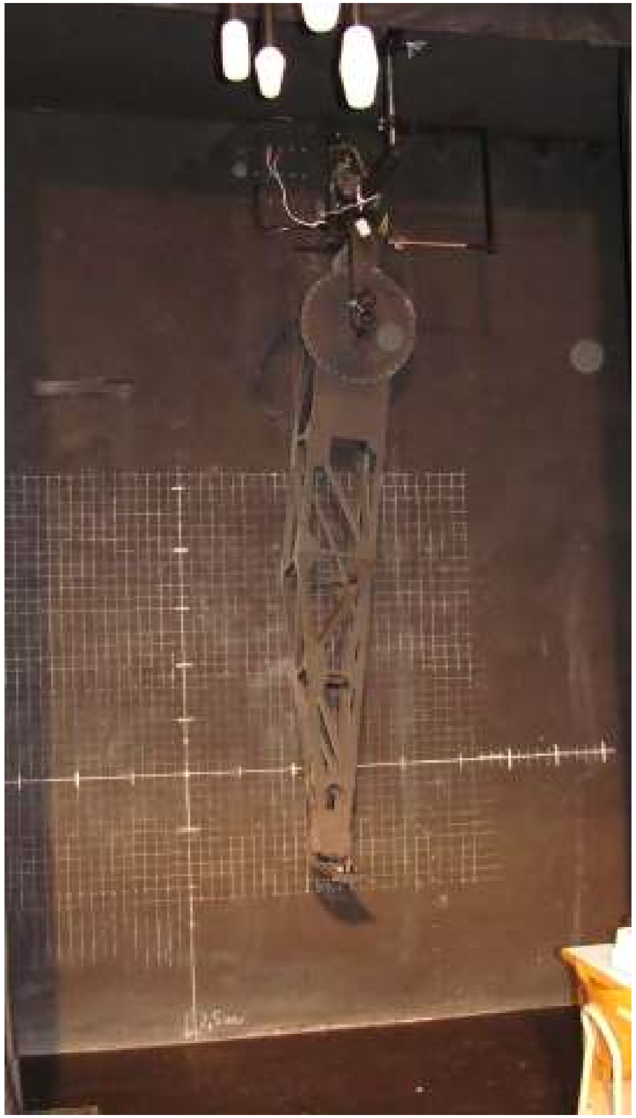
  CUReT:Columbia-Utrecht Reflectance and Texture Database,

  http://www1.cs.columbia.edu/CAVE/software/curet (Year 1999),

  Oren-Nayar model for BRDF (used in PBRT software)

Luminaire Measurements for Six Luminaires at Czech Technical University in Prague

- Help of the department working also in lighting (Prof. Jiri Habel and Ing. Marek Balsky)

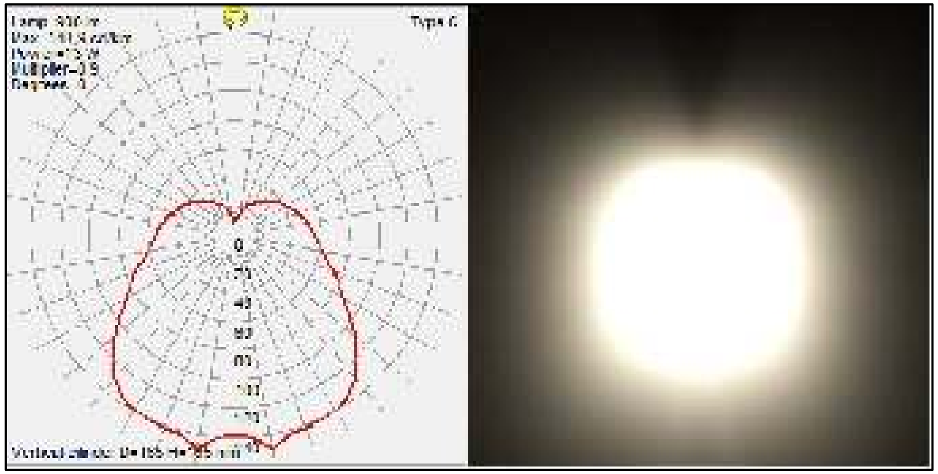


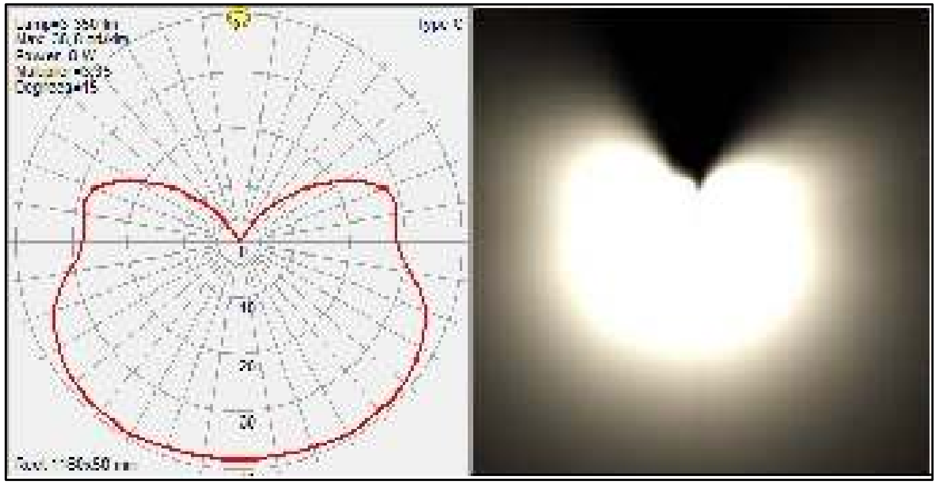
Goniophotometer used

Example: Emission Distribution Data for 2 Luminaires

Luminaire geometry

Emission goniometric diagram
(far field photometry)

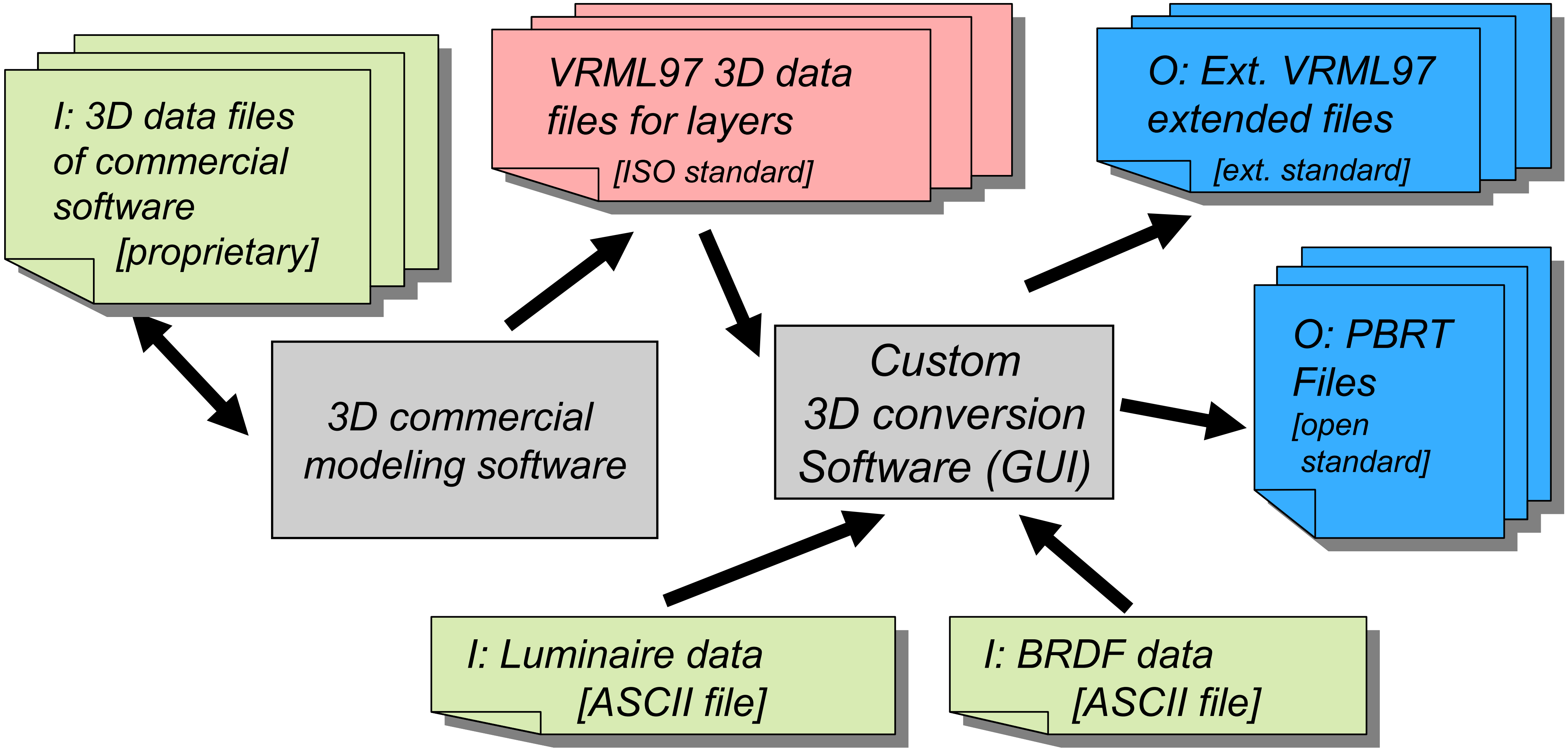




Far field photometry simplifies the light emission description
to directional distribution for a single point.

Conversion Data Flow and Processing

- Export feature from proprietary to open data format (geometry + luminaire + BRDF) from commercial software was missing.
- Large Scale 3D data – layers used. Name and data convection used during modeling in a software to allow the conversion and extendibility.



Results for Year 2009 – Project Website Content

Input data from the acquisition

- High dynamic range (HDR) photographs for 8 views under described lighting conditions from the real building.
- Many documentary ordinary photographs in the building (and 3 videos).
- Original geometry files provided by the architects of the building.
- Luminaire measurement recorded data and the measurement documentation.

Results for Year 2009 – Project Website Content

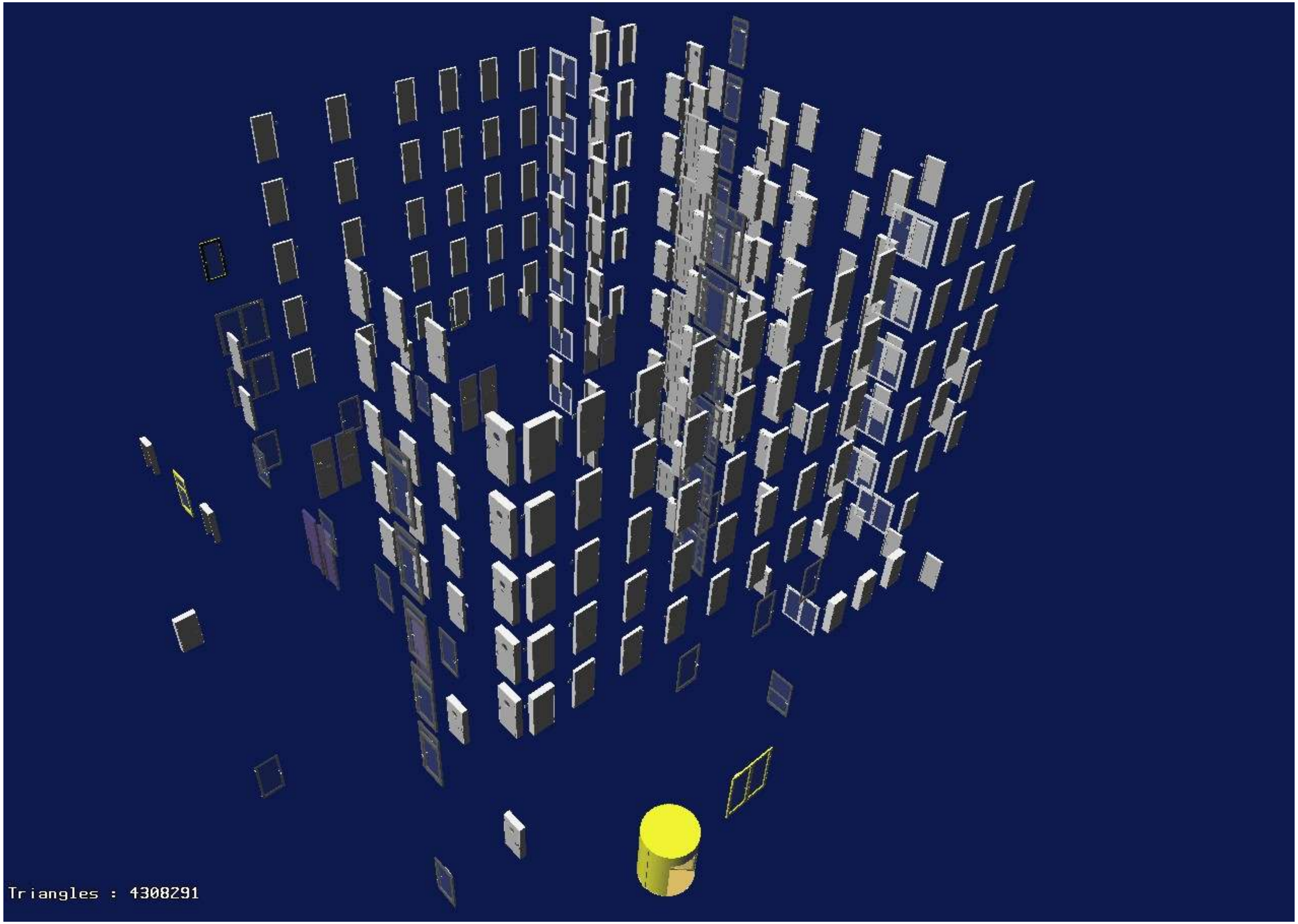
Output Data

- Far-field description of luminaires
- Estimate of camera viewpoints for taken HDR photographs
- Estimated BRDF of surfaces with the visual annotation
- Model geometry in the proprietary format of commercial software.
- 3D scene description (geometry + luminaires + BRDF) in PBRT and extended VRML format (+simplified version for standard VRML97) in semantic layers with previews. This allows custom model simplication.
- Gallery of individual (movable) objects in the building, mostly furniture with a preview and geometry in VRML97 and proprietary format
- Comparison between HDR photographs and rendered images for PBRT1.03 for three algorithms (ray tracing, instant global illumination, and path tracing).
- Gallery of miscellaneous images.
- MPII technical report 2009-4-004 describing the project (in progress).

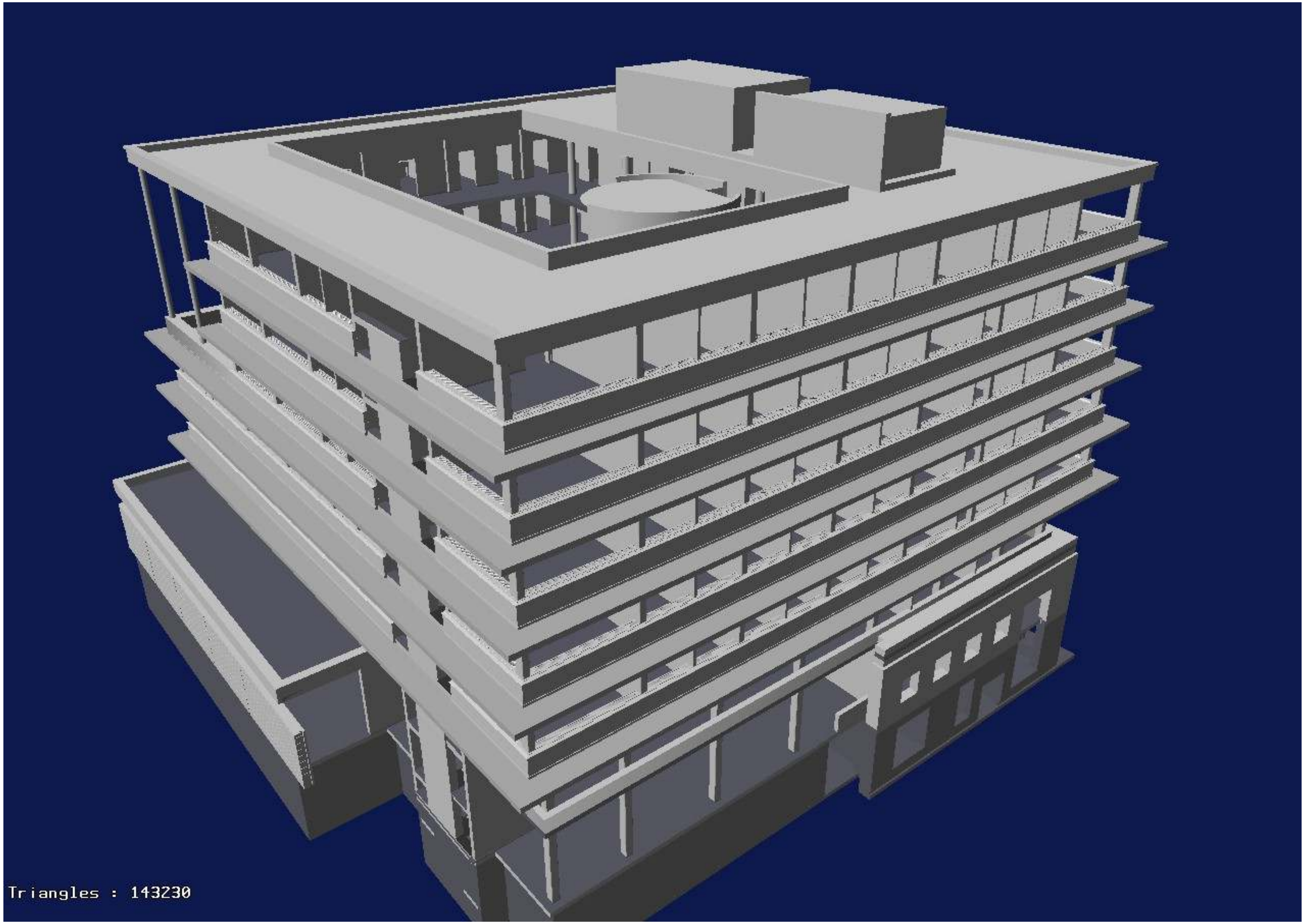
Website Proposal Possible Extension for Near Future

- Scanned technical drawings by architects for the whole building (requires approval by a MPII director).
- VRML to PBRT/eVRML conversion software for UNIX and MS Windows in C++ using cross-platform GUI based on wxWidgets library) requires:
  - translation from Czech to English
  - some source code polishing
  - maintenance resources

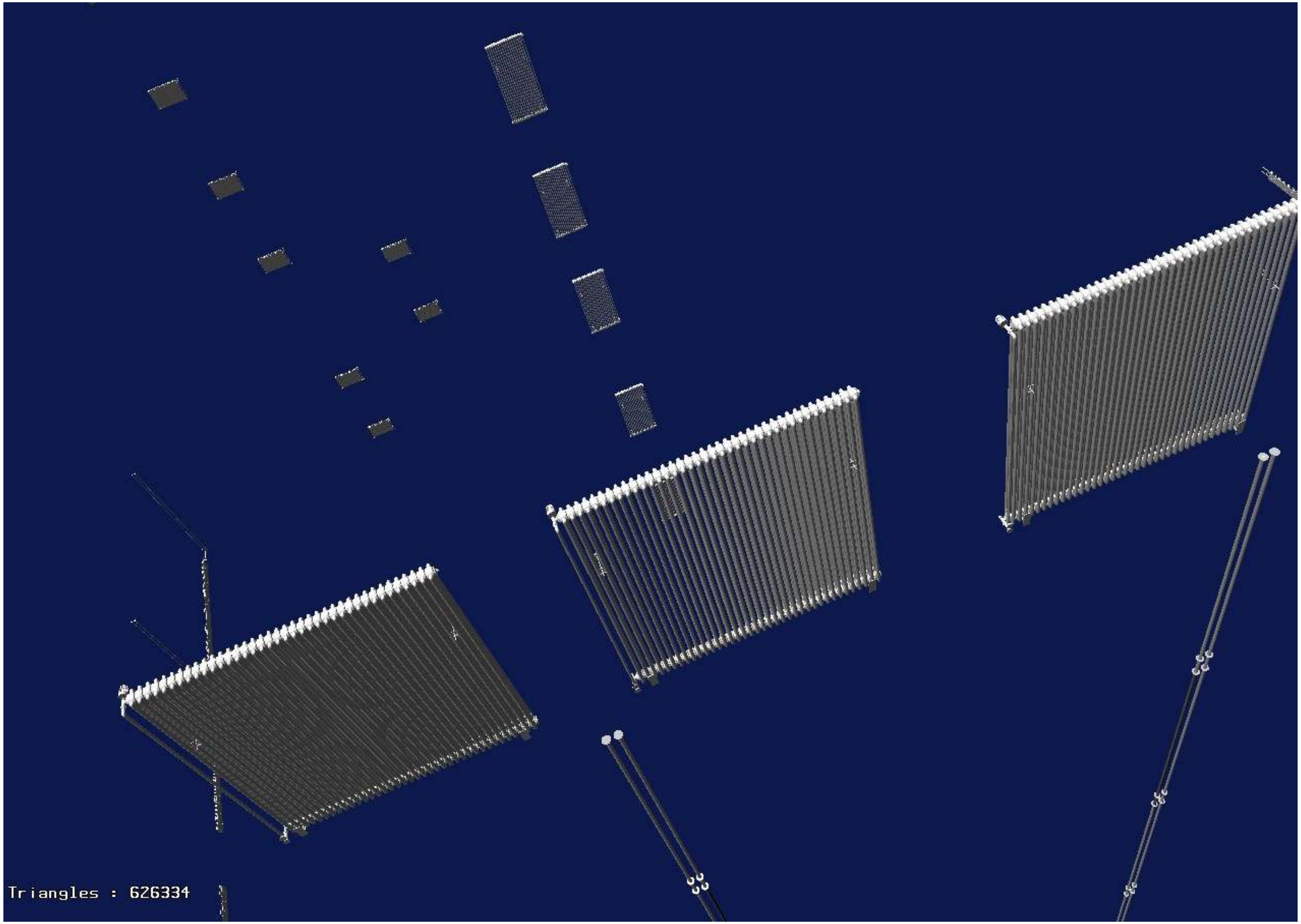
Geometry Layer Preview #1: Doors



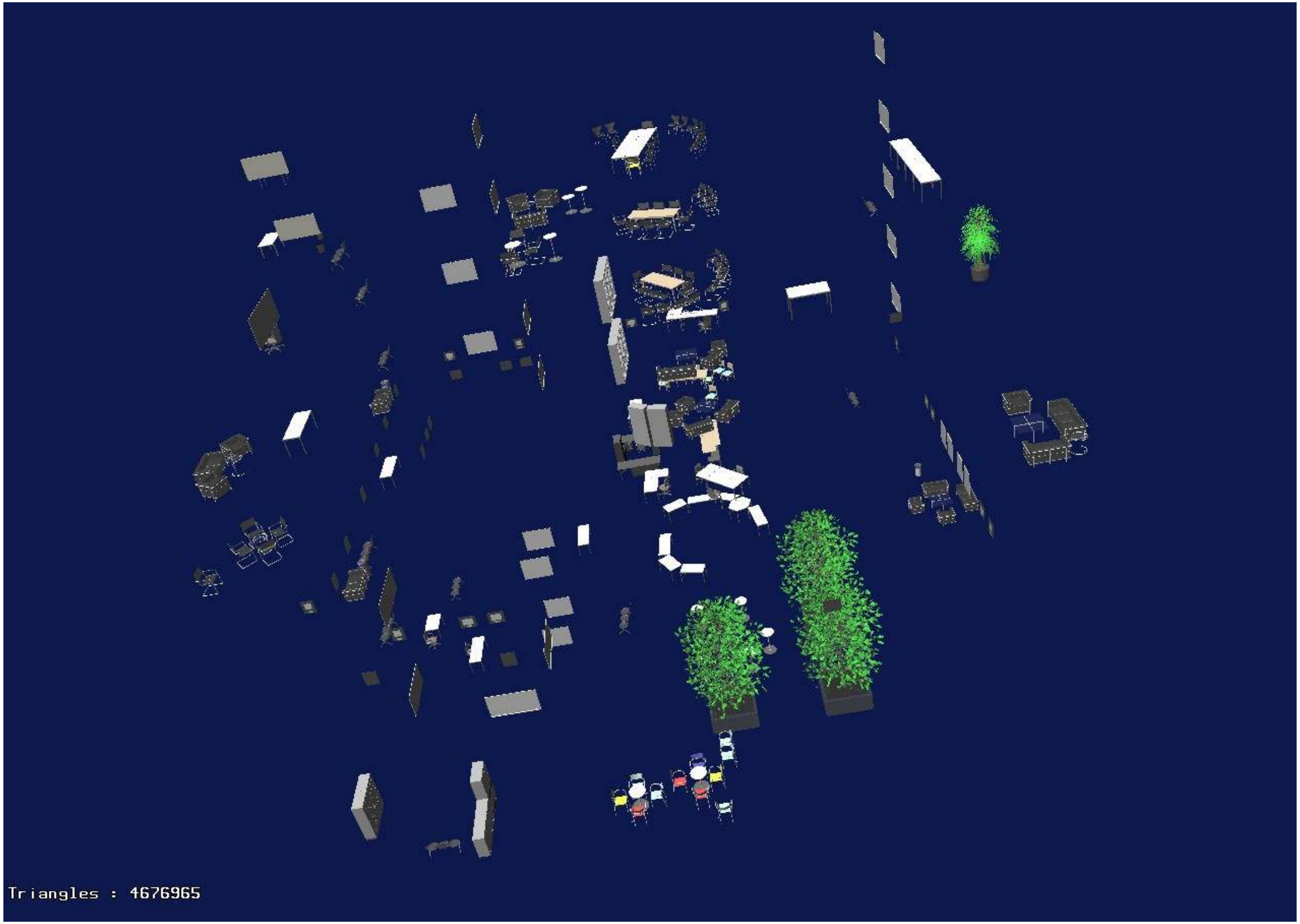
Geometry Layer Preview #2: Base Geometry



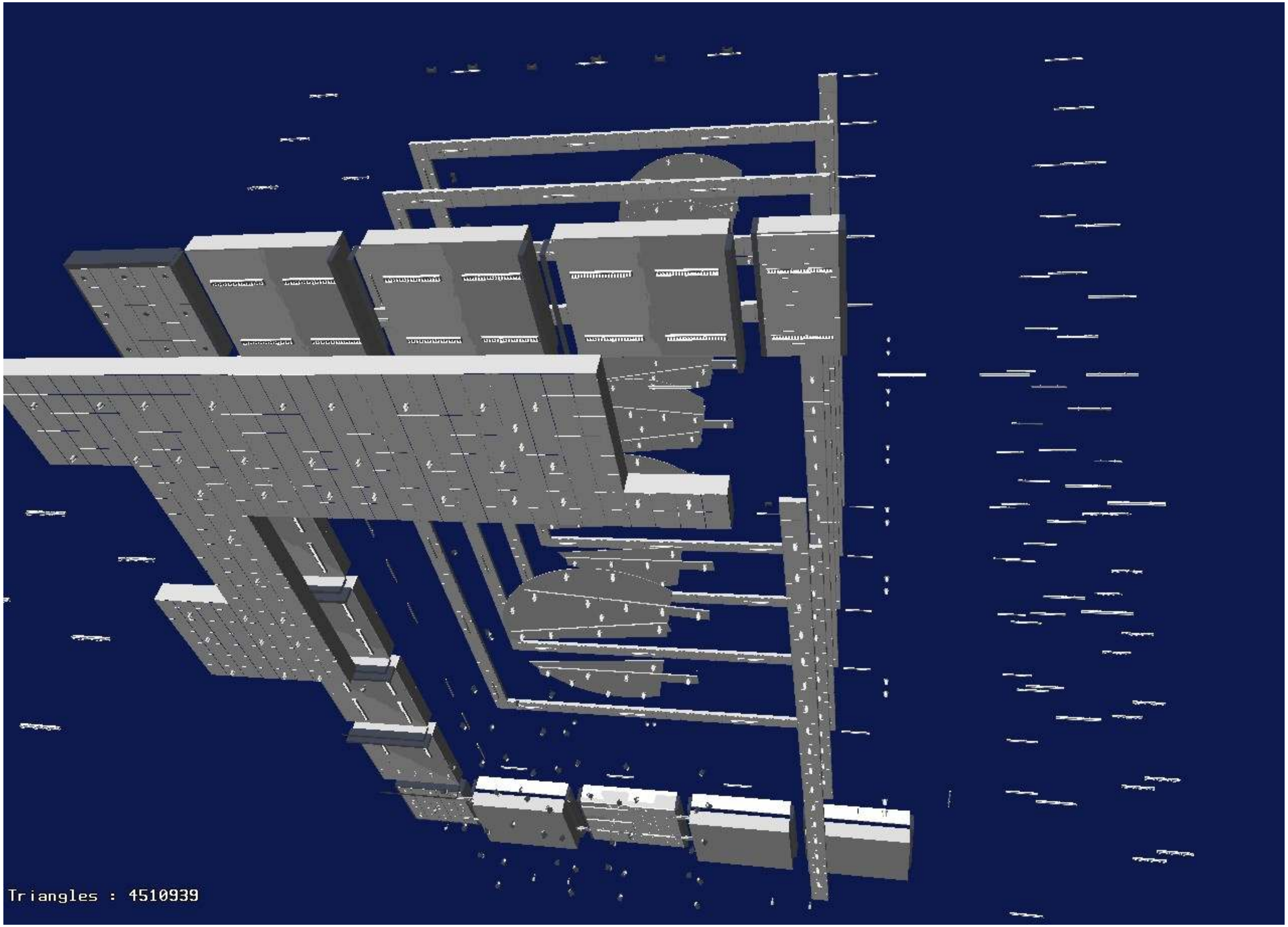
Geometry Layer Preview #3: Heating



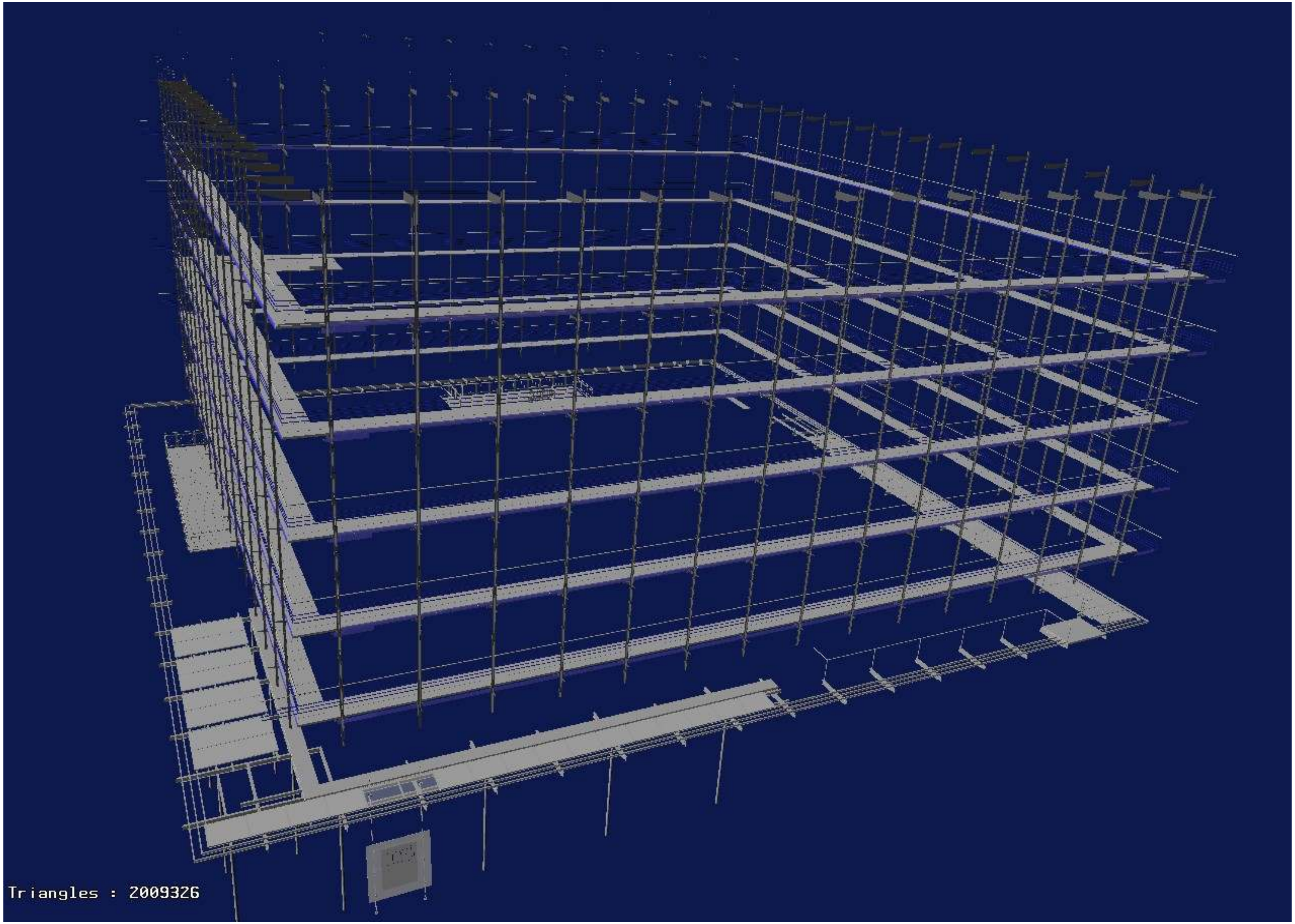
Geometry Layer Preview #4: Atrium Equipment and Furniture



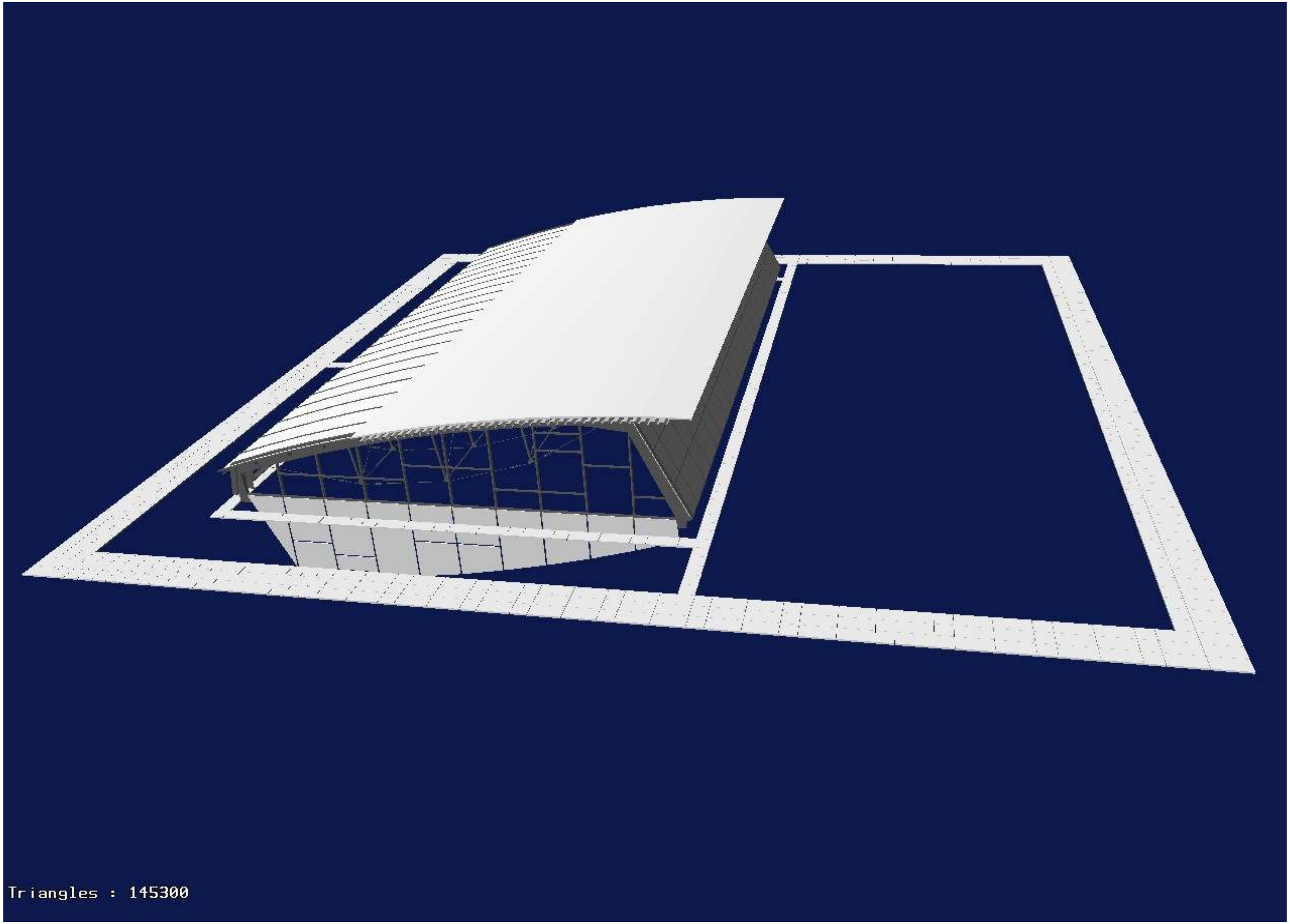
Geometry Layer Preview #5: Geometry of Luminaires



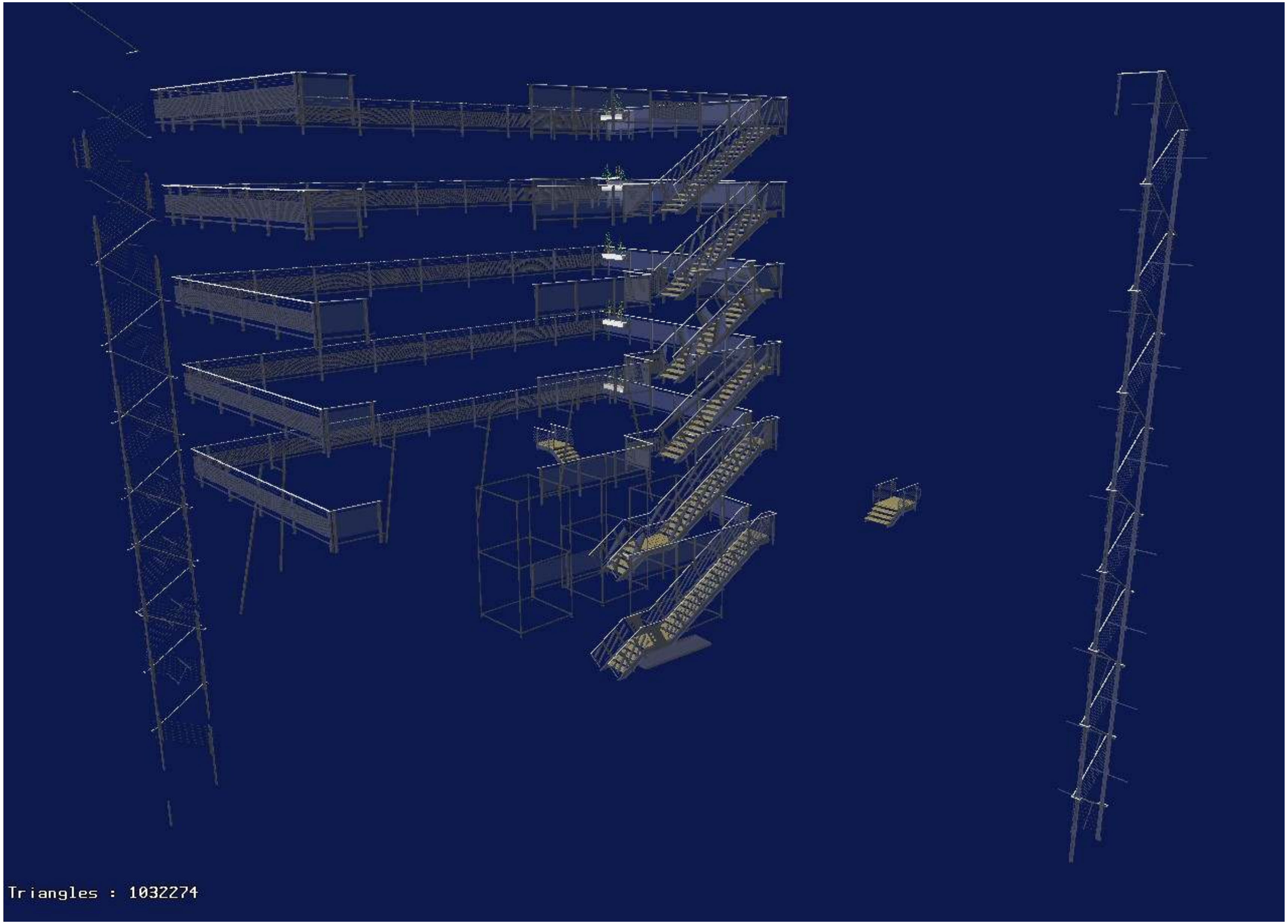
Geometry Layer Preview #6: Outer Construction



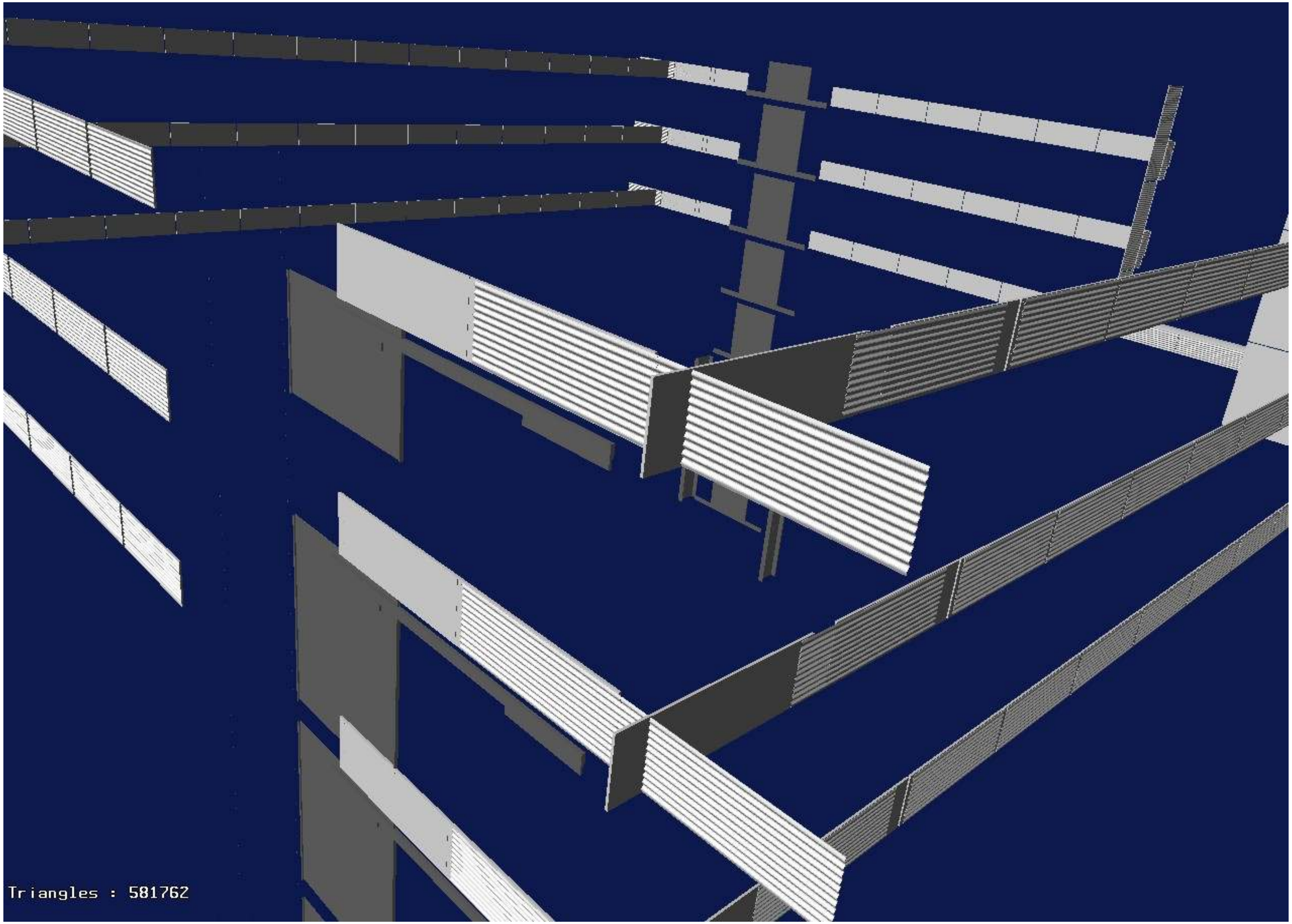
Geometry Layer Preview #7: Roof



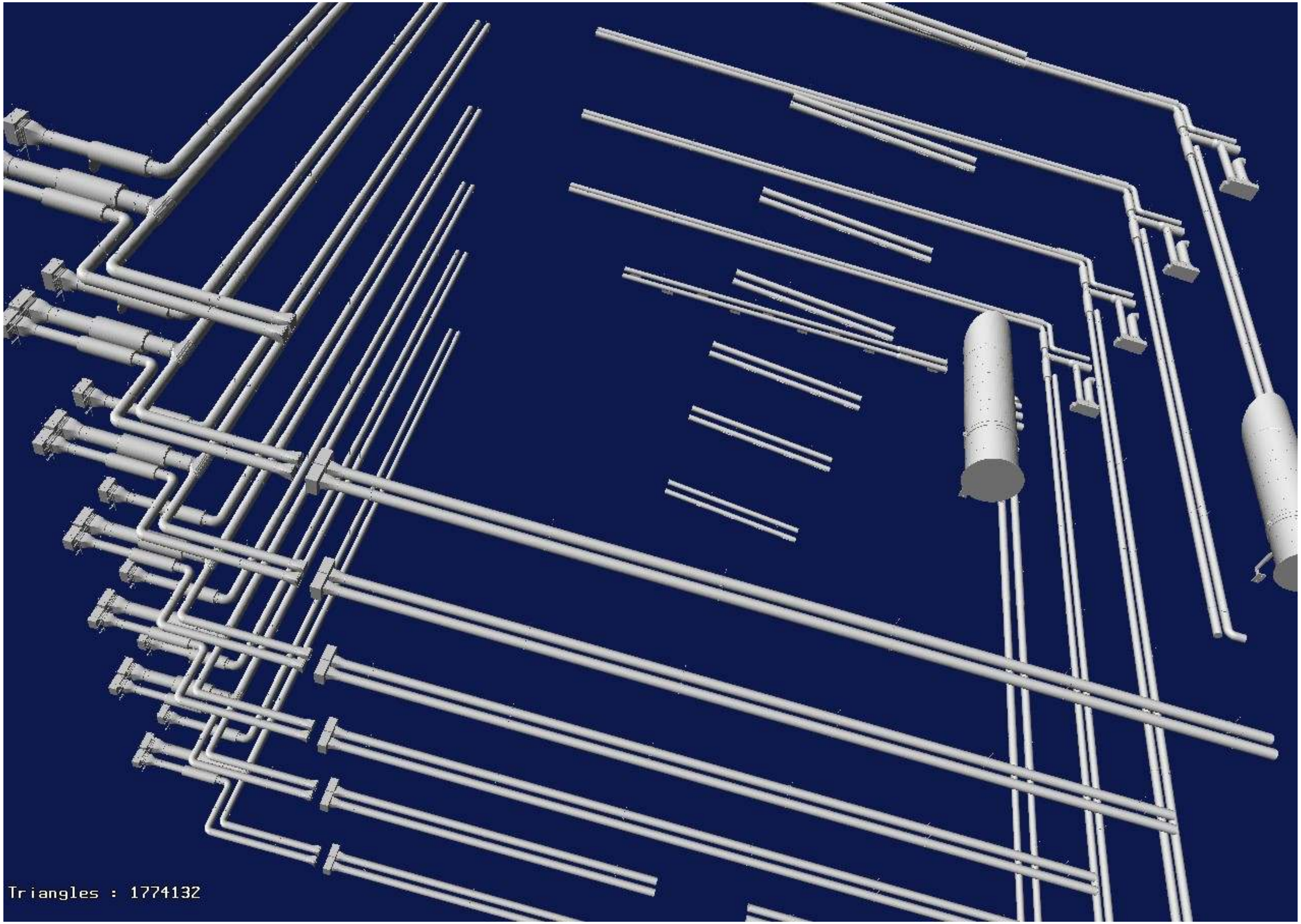
Geometry Layer Preview #8: Stairs and Fences



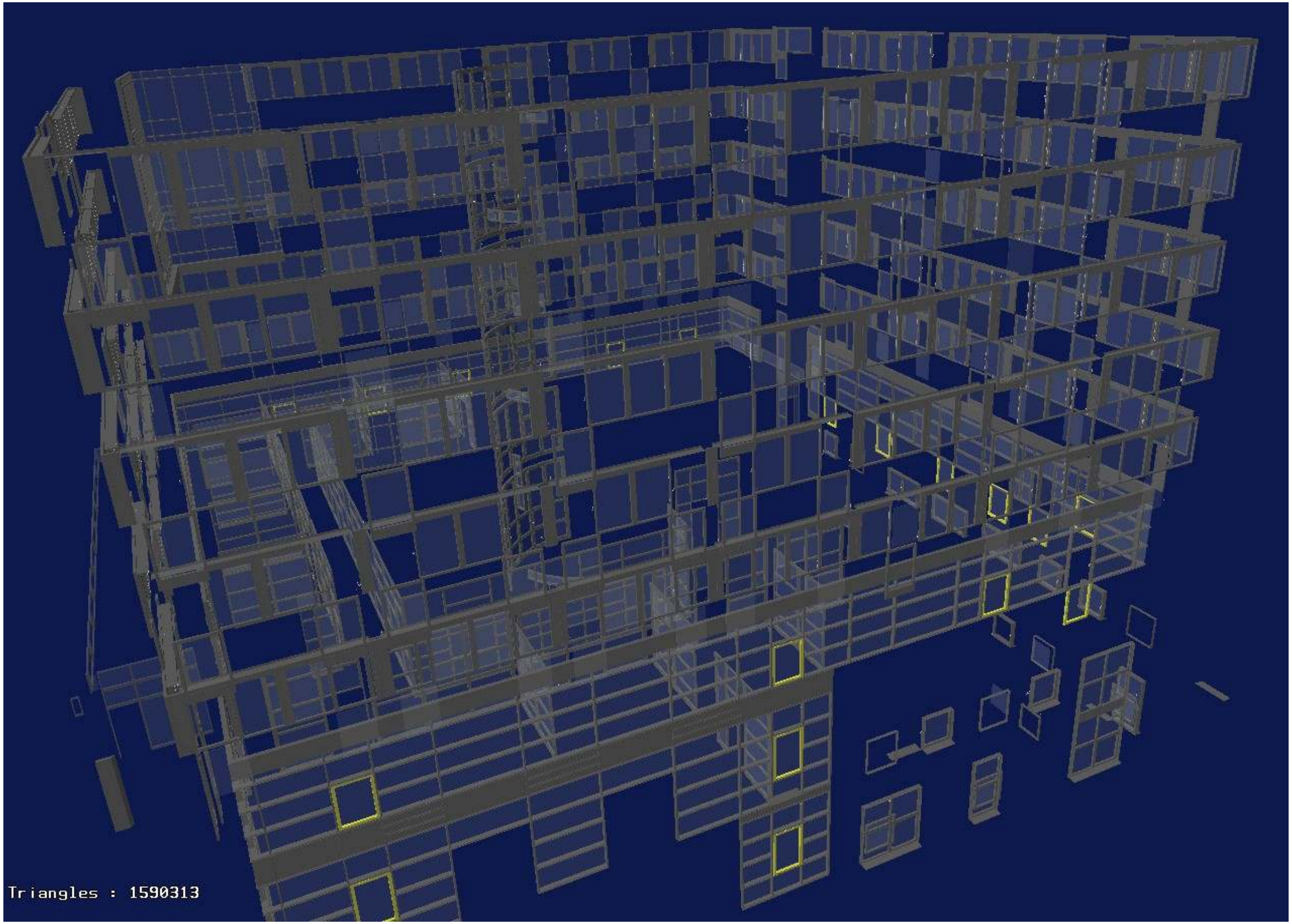
Geometry Layer Preview #9: Outer Thin Plates



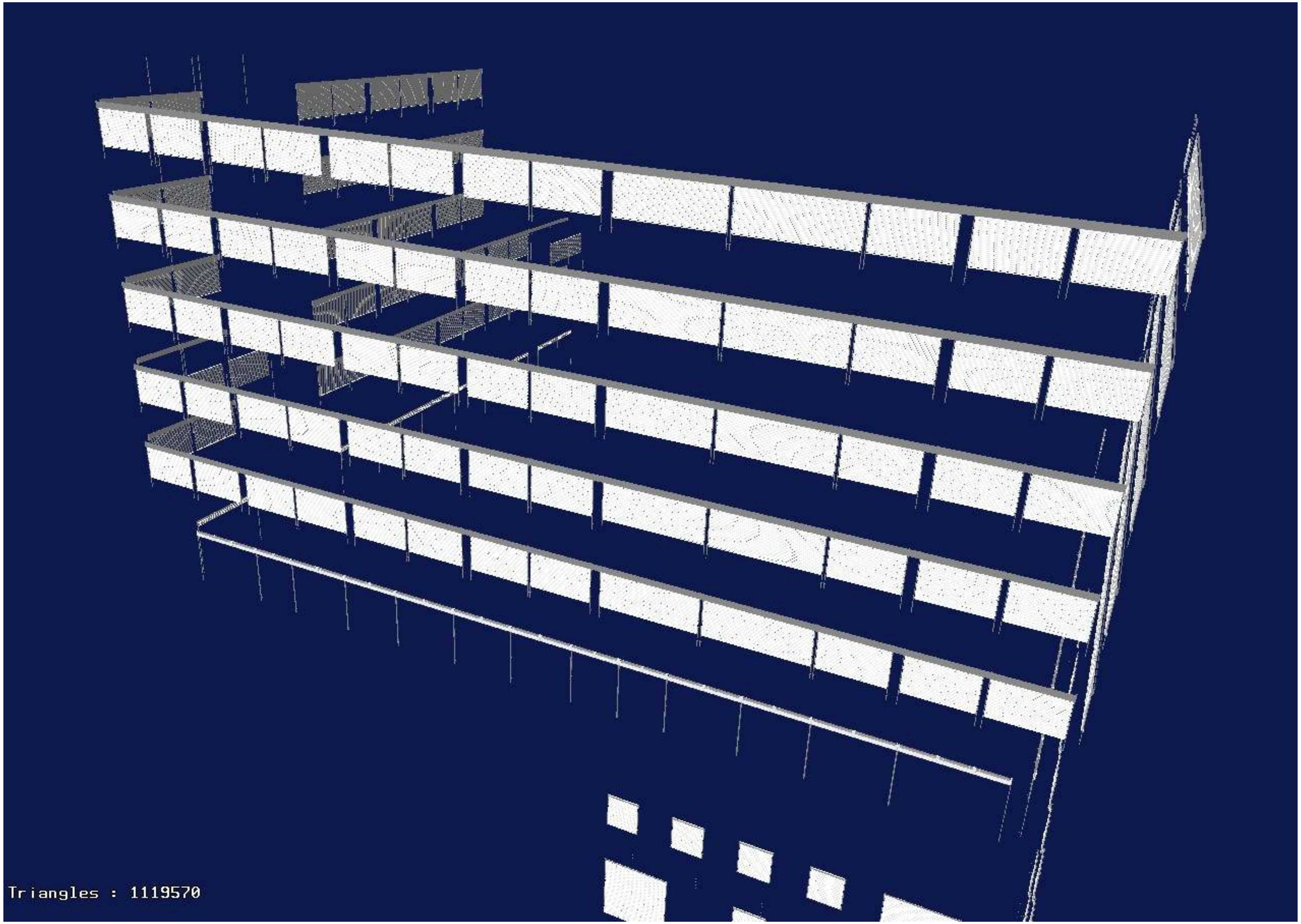
Geometry Layer Preview #10: Ventilation



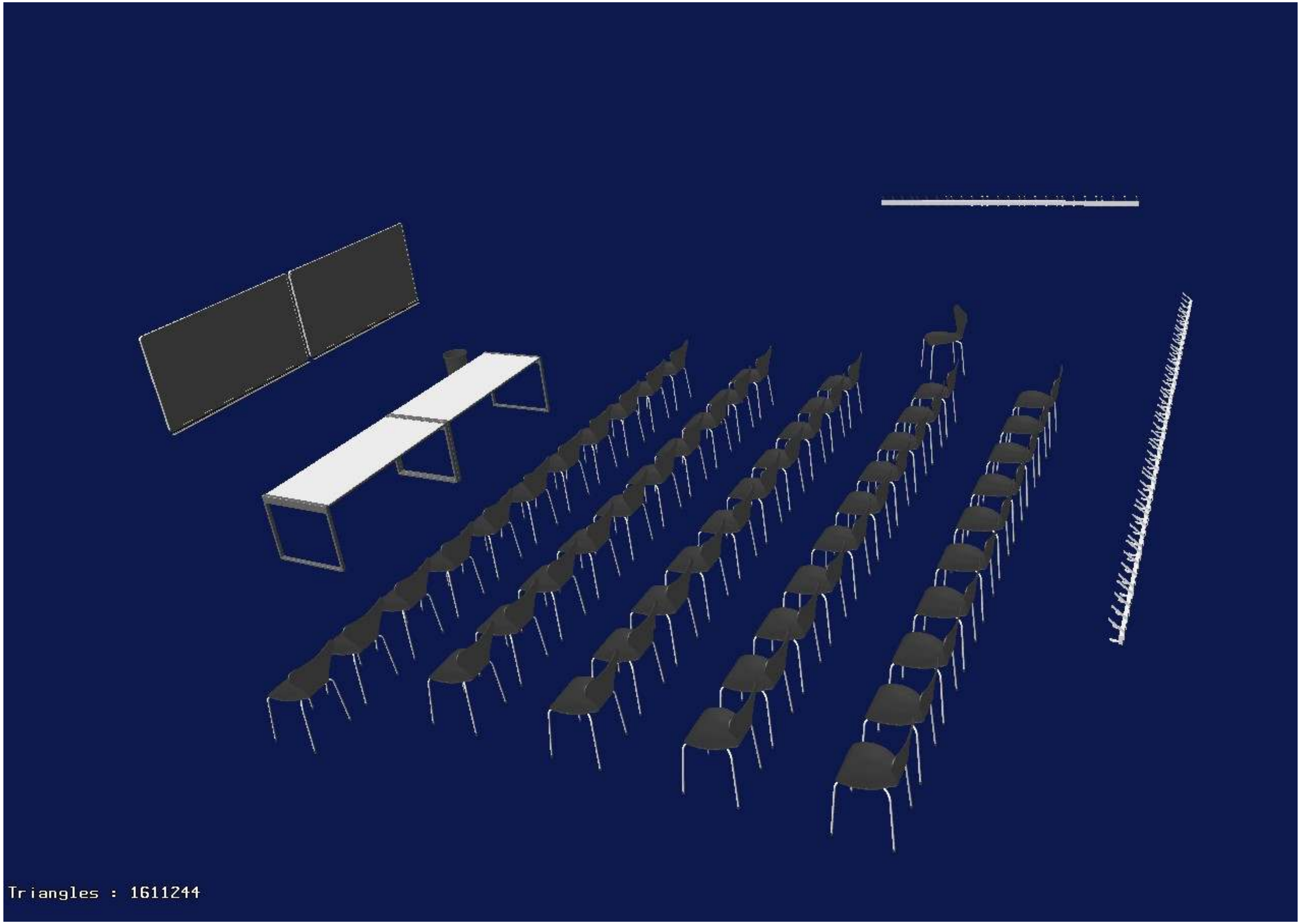
Geometry Layer Preview #11: Windows



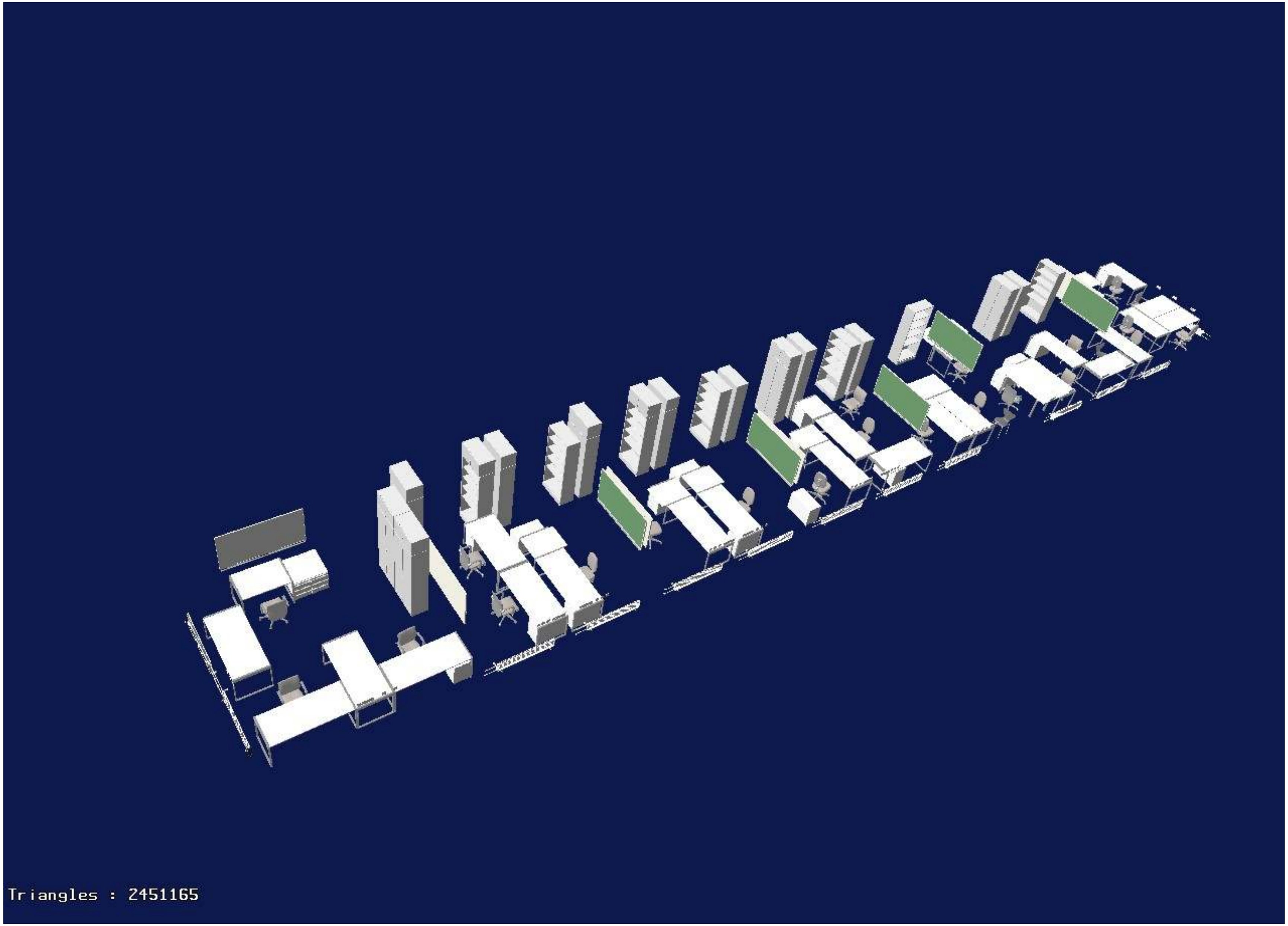
Geometry Layer Preview #12: Window Shutters



Geometry Layer Preview #13: Lecture Room 024



#14 - #34: Office Furniture, Organized to [North, East, South, West] x [2-6th Floor] + 1st floor, Example:



(Both regular and unique arrangements found.)

Comparison for Different Rendering Techniques

- PRBT software used (some problems with version 1.03)
- Selected eight views for photographs.
- Three methods tested:
  - Whitted-style ray tracing, 1981
  - Path Tracing by Kayija,1986
  - Instant Global Illumination by Wald, Kollig, Benthin, Keller, Slusallek, “Interactive Global Illumination using Fast Ray Tracing”, (Eurographics) Rendering Techniques, 2002
- Some problems found for the 3D geometry caused by the lack of backward compatibility of modeling software.

Comparison Views (Instant Global Illumination)

View #1

View #2

Comparison Views contd.

View #3

View #4

Comparison Views contd.

View #5

View #8

Comparison Views contd.

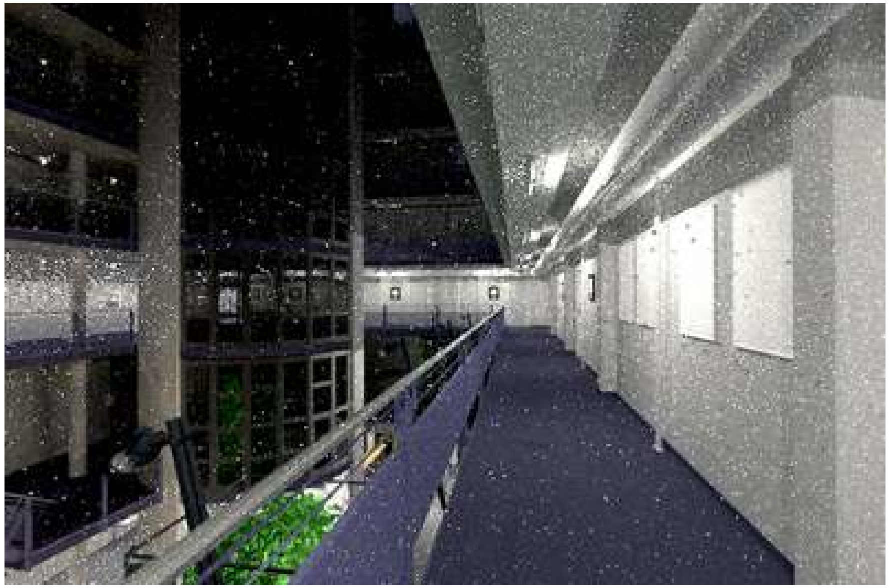
View #6

View #7

View #2 – Photo + Three Rendering Algorithms

Photograph

Path tracing



Whitted-Style Ray tracing

Instant Global Illumination

View #5 – Photo + Three Rendering Algorithms

Photograph

Path tracing

Whitted-Style Ray tracing

Instant Global Illumination

Data Model Accuracy and Limitation

Recall original project objectives (predictive rendering):

- focus on square atrium and corridor appearances.
- model limited by the size of the building walls and closest features.

- No parking lot and skywalk to CS building.
- No equipment in the underground floor (Building Administration Department) and no showers.
- No equipment and furniture on the ground floor for the administration department (rooms 002-017).
- No phone and defibrillator.
- No equipment and furniture for rooms 016-023.
- No furniture for south and east 1st floor (Information Services & Technology and IMPRS).

Data Model Accuracy and Limitation contd.

- No coffee machine and cups, 1st floor.
- No service ladder for the roof on the 6th floor.

GENERAL ITEMS

- No luminaire data in offices (emission, geometry is defined).
- No emergency lights (emission description, geometry of luminaires is defined).
- No kitchens, toilets, printer rooms, cleaning rooms.
- No “Klang-und Licht Installation” by Peter Vogel.
- No art exhibitions anywhere.
- No furniture of group directors and secretary rooms.

Data Model Accuracy contd.

- No computers and typical researcher environment of different complexities….

Data Model Accuracy contd.

- No people.

Many thanks to Akiko Yoshida for her help with HDR photo acquisition in July 2004 !

Some Numbers about the MPII Building Model

- November 2004 – **63,162** meshes (VRML97 index facets) defining **23,127,287 triangles**
- July 2009: **103,943** meshes defining **73,216,589 triangles** organized in **35** layers (allows simplification and selection)
- Really exactly ? Unsure. Robustness - epsilon-based algorithm – triangles - degenerated to a point or a line. Several software reported different numbers.
- **623** light sources (excluding those in offices), **7** types of luminaires
- **54,595** instantiations including recursive ones
- **128,393** transformation matrices
- **53** distinct BRDFs, **0** textures, **8** HDR photos taken
- Storage needed for the webspace: approx. **10** GBytes
- Work spent: approx. **4,500** hours (me, Josef, and Jiri), more than **300** e-mails in **4** languages, **2** visa arrangements, approx. **100** phone calls, **1** intermediate report, **1** Master thesis **(240** pages), **1** award for the Master Thesis.

Exploitation and Algorithmic Problems:

- Exploitation in computer science:
  - large scale of sizes for geometry (ratio up to 1:1000)
  - data size challenge for some algorithmic problems and majority ordinary hardware today (including recent GPUs, July 2009)

- Computer Graphics
  - predictive image synthesis, lighting design, accuracy and performance test
  - real time rendering, accuracy of approximate algorithms in complex scenes
  - benchmark dataset for performance of particular hardware
  - modeling algorithms
  - reference dataset for automated reconstructions
  - environment for presentations
  - etc.

Exploitation and Algorithmic Problems contd.

- Computational geometry and other algorithmic problems for 3D data:
  - range searching (ray shooting, nearest neighbor search etc.)
  - robustness of geometric computations – one algorithm output:

    #number of found degenerated facets: 516,488

    #degenerated facets to a point specified: 70,088

    #count degenerated facets to a line segment: 445,263

    #count degenerated facets for triangle from input file: 1,118

    #degenerated facets for triangle as result from a triangulator = 0

    #count zero normals from input file = 7

    (*Note: the numbers above should be verified independently.*)
  - triangulations, remeshing
  - data conversion
  - texture parameterization

Exploitation and Algorithmic Problems contd.

- Computer Vision
  - reference data set for virtual reconstruction of a large 3D scene (rendered and for some viewpoints taken in the real building)
  - simple reference individual objects for 3D shape matching
  - technical drawings digitization
- Spatial databases algorithms
- Sound propagation algorithms
- Some others? Let me know.

(Other non-research exploitations for MPII).

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- my co-workers Josef Zajac and Jiri Drahokoupil for their hard work and brevity fighting the problems and large scale complexity data.
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- Michael Laise and Axel Koeppel from MPII building department for providing several spare parts from the building.
- Prof. Wolfgang Paul for his willingness to search the old 3D data on a tape, thirteen years old.
- Building architects from Kaiserslautern for providing us initial data.
- Akiko Yoshida, Prof. Jiri Habel, and Marek Balsky for their help with data acquisition.

Future Work Plan

- Completing technical report MPI-2009-4-004
- Correcting some known problems before initial release.
- Releasing initial version V1.0 – date 1st December 2009

- Releasing model V1.1 in 2010 – problems correction based on the feedback.

- Possible future work on MPII Building Model V2.0

  (within 2011 and 2013)
  - Correcting geometric problems.
  - Increasing complexity by further details?
  - Parametrical model – movable geometric data (doors, windows, window shutters).
  - Acquisition of BRDF or BTF for 53 or more materials?
  - Near field photometry acquisition for luminaires?

Conclusion for MPI Informatics Building Model

- Representative publicly available real-world datasets are needed for many algorithmic problems and also required for reproducibility and the implementation validation of algorithms.
- Dataset from private companies should be avoided as much as possible in a research work if they cannot be made public.
- Preparation of valuable large scale datasets by yourselves is really difficult and at some point will become the subject of ingratitude (many researchers forget to give credits,...).
- Accuracy and level of detail of 3D geometric data sets is always limited compared to the real world – we have an approximation (and MPII building is changing all the time).
- Each dataset will become obsolete in future – estimate for the MPII building model lifetime for research use is next 10 to 12 years (year 2020).

Conclusion contd.

- Many lessons learned – it was not wasted time.
- Comments to the project are welcome, we know about some problems with the data, but do not expect / require our immediate feedback.
- Please, help to disseminate the knowledge about this project in your research community. Thank you.
- Any support for this project is really appreciated.
- Project data are for the research purposes of yours and your colleagues, please, use it if it fits to your research needs. Otherwise, our effort is wasted. Thank you.
- The project website is located at:

http://www.mpi-inf.mpg.de/resources/mpimodel/

My Lessons Learned

- If you come to a research institute for one or two years, you can stay much longer.
- A project can take much longer than you expect.
- Backup your data regularly. It can never be repeated enough.
- Migrate the data from old type media to new ones, even for your old projects, it can be useful in future.
- Do not expect the compatibility of the same format for different software packages, even if they are destined to be de facto standard formats.
- Do not expect the backward compatibility of the different version of the same commercial product.
- Do not expect that export to some real standardized format is well supported in a commercial software, including key player on the market.
- Find the right people if you search for the data, sometimes you contact the competent person, but there are other persons with much faster response.
- Your project, regardless of its idea is nice, does not need to gain support of your colleagues, if their research profile fits the project needs.
- Even if you know all the above, it does not help you to avoid or solve the problem you have….

http://www.mpi-inf.mpg.de/resources/mpimodel/