



When *Archaizing Architecture* meets BIM

ARCHICAD-based
GDL development and
applications for ancient
style architecture by T.R.
Architectural Design

China is one of the world's ancient civilizations. Chinese architecture features the unique culture and history of China. It is beautiful in shape, rigorous in structure — magnificent but exquisite, majestic but elegant. The Treatise on the Architectural Methods of the Song Dynasty (Yingzaofashi) is an ancient classic representing the top science and art of ancient Chinese architecture, recording valuable materials of the system, practice, craftsmanship and set patterns of Song Dynasty architecture. Thus, it is of far-reaching significance to the study of Chinese architecture and understanding its concepts and philosophies.



Zhejiang T.R. Architectural
Design Co., Ltd.

Project Name: Liuzhou Yaobu Ancient
Town Sightseeing Pavilion

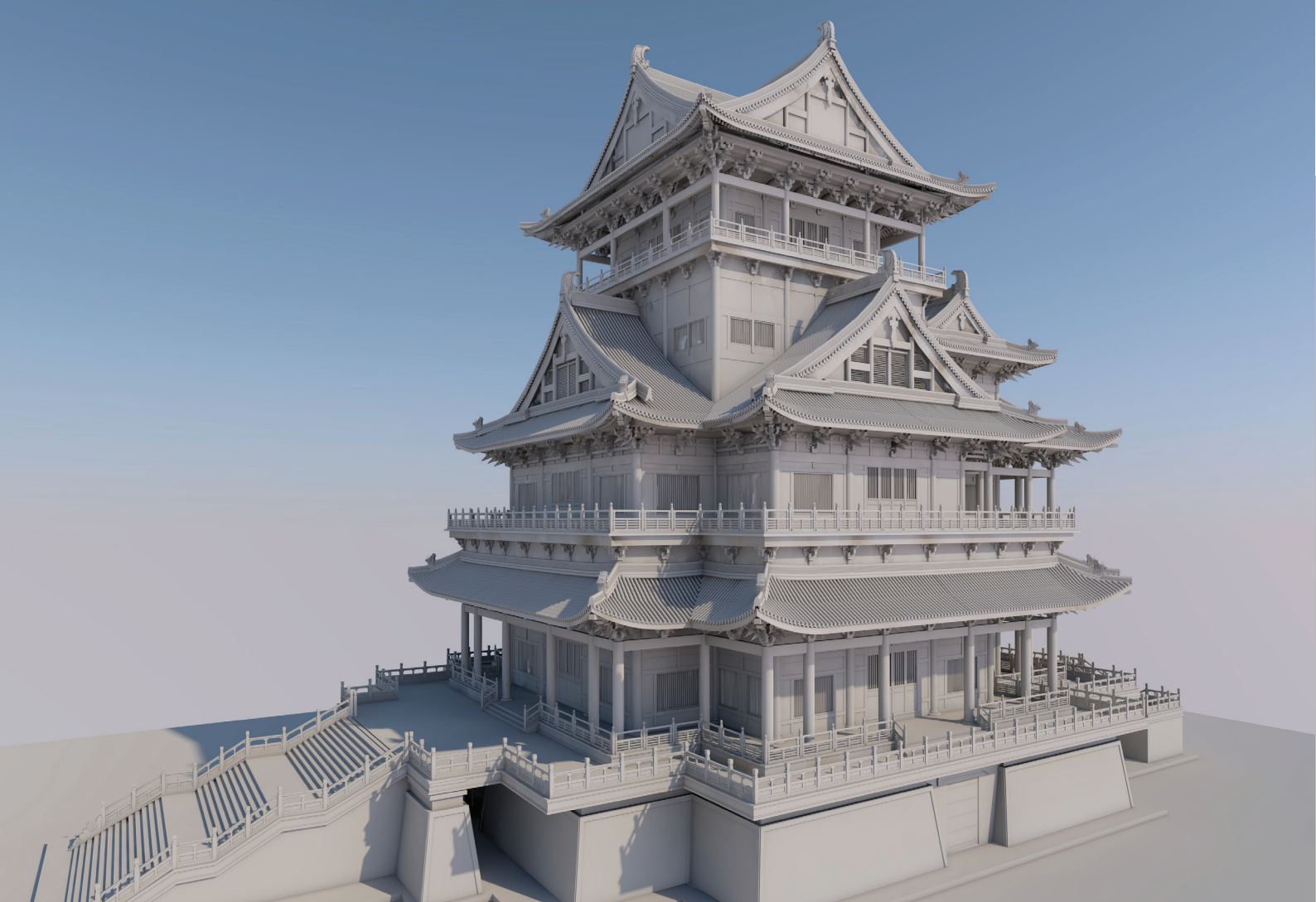
Construction area: 4580 m²

Height: 33 m

Address: West Side of Panlong Road,
Liuzhou City, Guangxi

Chief Architect: Lu Yongle, T.R. Partners
Architectural Design Co., Ltd.
Deputy Chief Architect

Designer Team:
Pan Congfang, Xu Mengshi, Liao Shiguo
(The Design Institute of Landscape and
Architecture, China Academy of Art)



Liuzhou Yaobu Ancient Town Sightseeing Pavilion / Lu Yongle

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Lu Yongle
Deputy Chief Architect
Zhejiang T.R. Partners
Architectural Design Co., Ltd.

BIM Applied in Ancient Style Architecture Projects

T.R. Partners Design has always adhered to the philosophy of “surpassing the competition with distinctive designs.” We have taken the lead on integrating BIM with ancient architecture design, providing effective solutions to the exploration of the information-based design of ancient style architectures.

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The Sightseeing Pavilion project in Liuzhou is in the Tang Dynasty style. The architecture from the peak of the Tang Dynasty was magnificent and spacious. The design of courtyards was often natural and featured various layers. Pavilions were grand, with gently curving roofs, firm and strong corbel brackets and eaves reaching out gracefully. The wooden structures were truly ingeniously designed. In addition, they were elegantly decorated, yet understated.

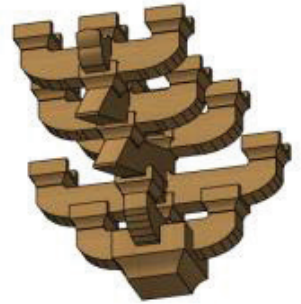
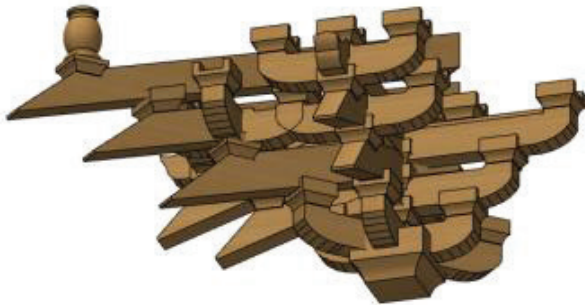
Liuzhou Yaobu Ancient Town Sightseeing Pavilion / Lu Yongle



Applied Technologies

The Liuzhou Sightseeing Pavilion has a high platform foundation, a triple eave roof, a hip-and-gable roof on four sides and a height of over 30 meters. While using BIM for its design, we maintained the Tang Dynasty style as much as possible and borrowed some architectural methods from the Treatise on the Architectural Methods of the Song Dynasty. Corbel brackets (Dougong) were used as corner bracket sets with a single horizontal and three vertical arms, as well as beam end bracket sets with a single horizontal and two vertical arms. “One cai of each kind

Six corner bracket set with a single horizontal and three vertical arms, and a beam end bracket set with a single horizontal and two vertical arms.

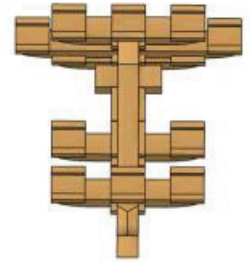
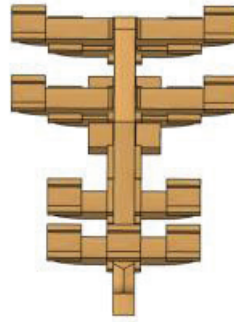
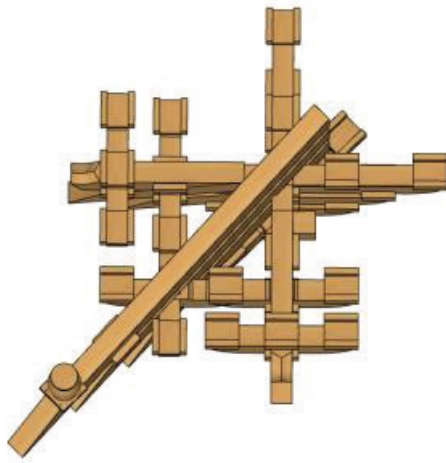


“One cai of each kind of timber is divided into 15 fen by length and 10 fen by thickness. The height of rooms, the length of objects, the height of curved or straight roof structures, and the sizes of circles, squares, lines and planes are all measured with the cai and fen of the specific kind of timber.”

Treatise on the Architectural
Methods of the Song
Dynasty

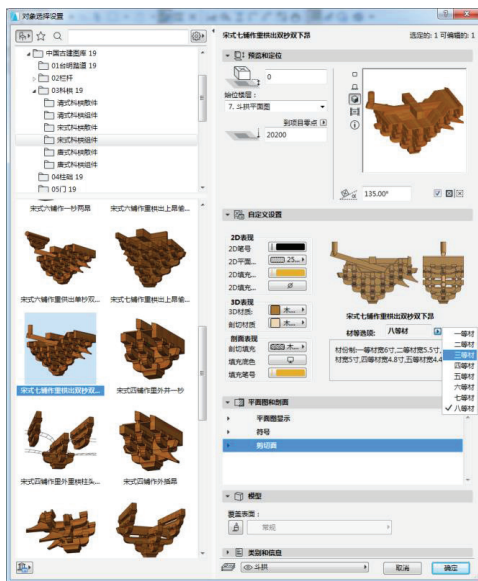
of timber is divided into 15 fen by length and 10 fen by thickness. The height of rooms, the length of objects, the height of curved or straight roof structures, and the sizes of circles, squares, lines and planes are all measured with the cai and fen of the specific kind of timber.” —Treatise on the Architectural Methods of the Song Dynasty

Simply put, cai — the gong (horizontal arm) profile of the corbel bracket — is used as the basic unit of the modules. With years of experience in ancient style architectural design, the design team referred to a large volume of related literature, studied existing ancient style architecture, and consulted ancient style architecture craftsmen. With our knowledge of spatial visualization, logical thinking, multi-dimensional geometry and math, the designers created various kinds of complex parametric components and composed many parameterized elements by using ARCHICAD GDL, which left considerable room for our designers to expand on and innovate, and has also made it possible for the module and assembly method of the ancient architecture to be truly, effectively integrated with the latest BIM technology. We have applied this approach in many of our ancient style architecture projects, and we hope it can be used for ancient architecture protection and restoration, as well as for the design of ancient style architecture.



Challenge 1: Design and Assembly of Bracket Sets

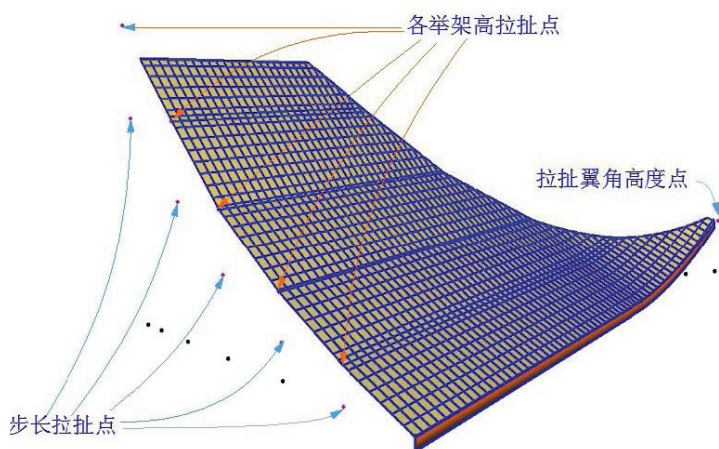
The detail size of different kinds of dou (square sockets) are set separately to be parameterized in BIM before properties such as 3D shapes, 2D symbols, textures, line types and colors are programmed with GDL.



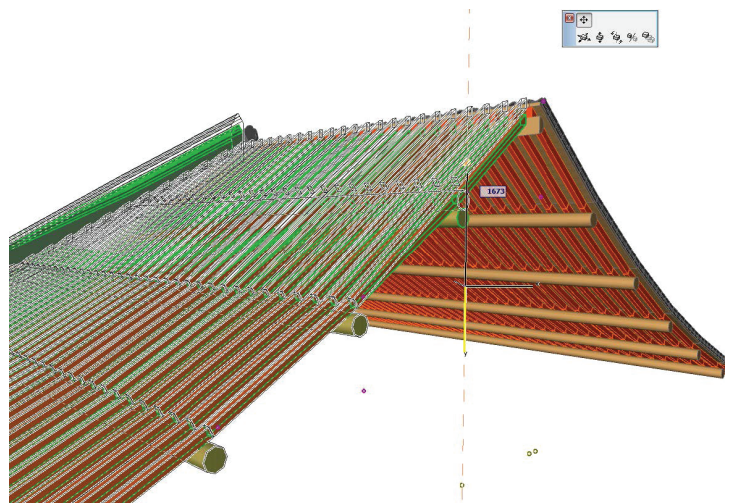
Challenge 2: GDL Elements for Roof Trusses and Curved Corners

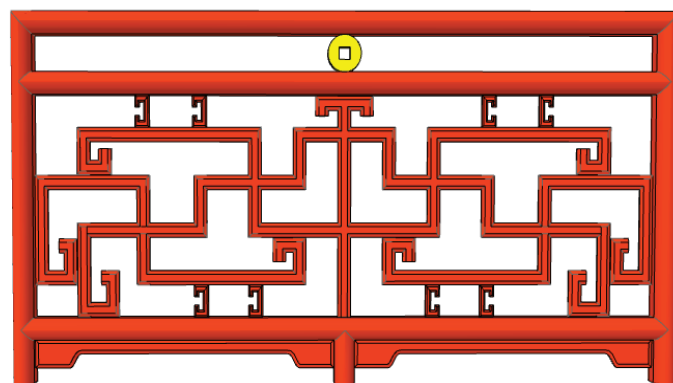
The algorithm for roof design is much more complicated than that for bracket sets. It should conform to the dimension rules of ancient architecture and, at the same time, be calculated and presented with trigonometric functions from solid geometry. In real cases, the architecture varies from one case to another and can even be designed without following the dimension rules used in ancient times. Designers must be given a certain degree of freedom and convenience.

We have many hotspots in the roof GDL elements. By using the parameterization system for the ancient style architecture roof design, the sloping roof can be constructed quickly, and the height of the roof structure can be adjusted at any time.



用法 (3D)



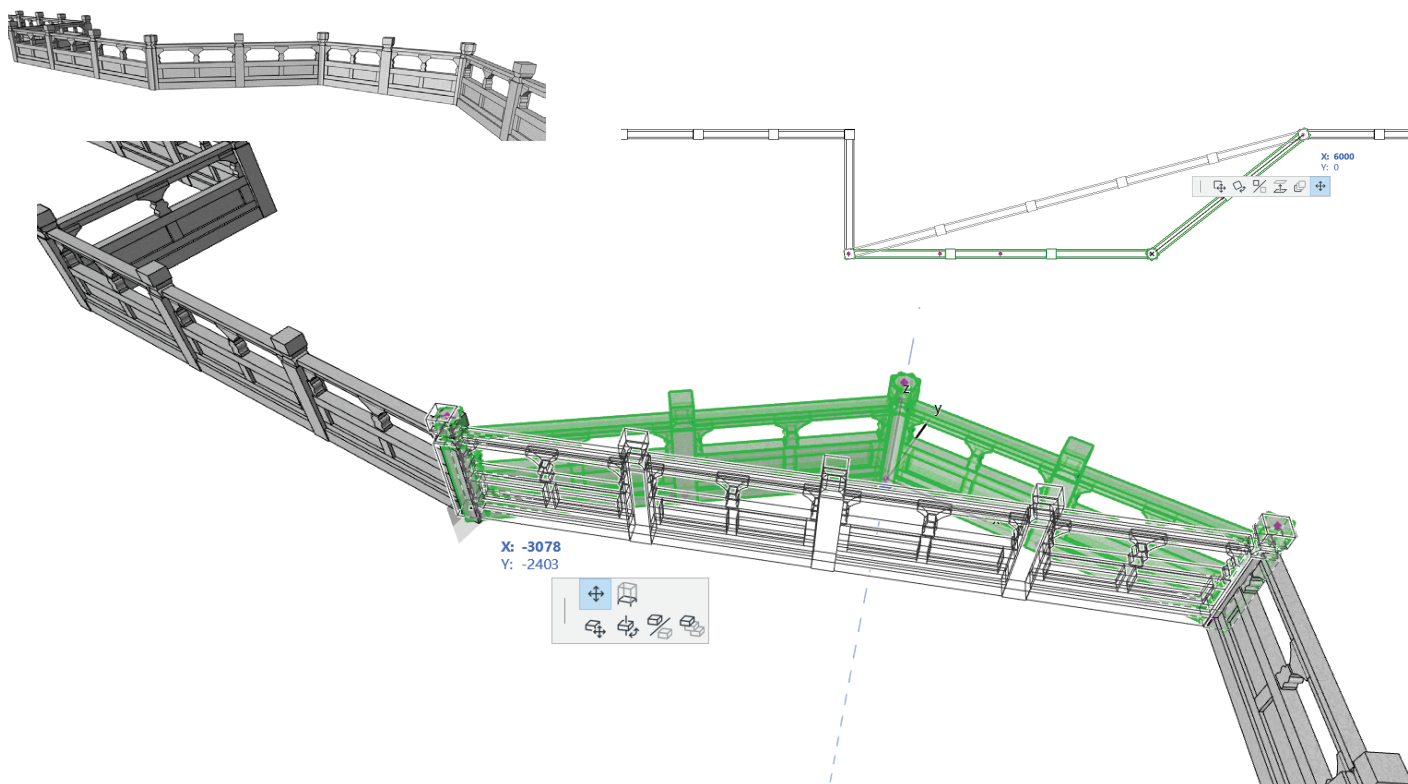


Railings in Ancient Chinese Architecture

Challenge 3: Railings

There are a variety of railing styles in ancient Chinese architecture. These railings are an important user-friendly element in historic architecture and enrich the horizontal profile of buildings. Customized GDL ancient architecture railings can be made into various styles through grouping support columns and infill panels. We have created, in particular, two key algorithms for the railing system, namely: dragging a hotspot automatically adds nodes; and infill panels units can be automatically matched with the lines.

Just drag the hotspot and you get infill panels automatically. This truly represents the intelligence of GDL parameterization.



Why ARCHICAD?

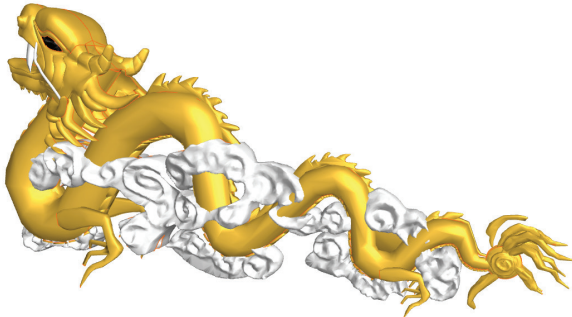
"ARCHICAD is more convenient to use and more adaptive to the way architects think. BIM technology is sufficiently mature. The software is light and easy to operate. These features play a key role in the entire design process. We have also found during the design and construction process that ARCHICAD not only provides perfect and efficient solutions for architects in designing modern architecture, but also resonates with the way that ancient style architecture craftsmen think.

ARCHICAD visualizes designs gracefully and in various ways. Its 3D documents, BIMx and OpenBIM concepts are compatible with other BIM software, achieving the ultimate exchange of information. This is exactly the reason why our architects love ARCHICAD.

Using ARCHICAD, we created galleries for 15 categories of historic architecture, including those made from stone and tiles, as well as structural carpentry, doors and windows.

These parametric elements have been tested in real projects. This gave experience in optimizing and creating new generations of elements. We created GDL elements for the ancient style architecture of the Tang, Song, Ming, Qing and other dynasties. Structural carpentry was constructed in

ARCHICAD gallery of historic Chinese architecture and GDL elements for ancient style architecture of the Tang, Song, Ming and Qing dynasties.

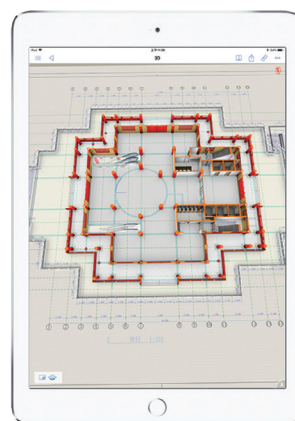
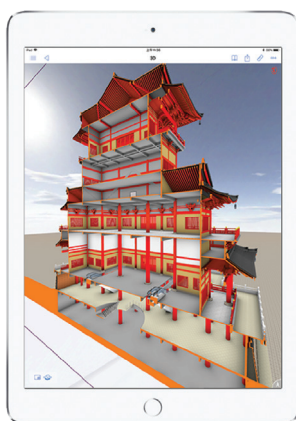


accordance with the Treatise on the Architectural Methods of the Song Dynasty. Doors and windows were added for joinery work; bricks, tiles and stone elements were added for brick and tile work. This was our approach when developing the GDL ancient style architecture gallery."



BIMx's application integrating graphics and models can easily and perfectly show complex architecture, even on mobile devices, which makes it convenient for clients to make decisions and provide feedback. It is even helpful when teaching about historic buildings.

The cai-fen modular system fully represents the ingenuity of the construction methods of traditional Chinese architecture. In plain English, it can be understood as mathematical formulae, the standardization of nodes, the parameterization of elements, and assembly-based construction. It is a system that has made historic architecture notably special over the long course of history.



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Zhejiang T.R. Architectural Design Co., Ltd.

Architectural engineering design first class certificate No.:A133009451. T. R. Architectural Design provides services in architecture, landscaping, remodeling, BIM consulting, etc. We are known for our rich experience, excellent designs and good word of mouth from the services we have provided. We win the market with our distinctive designs. This is the philosophy our company has always adhered to. Our designs not only include normal buildings such as residences, schools, hotels and offices, but also focus on cultural architecture, especially designs of ancient Chinese style buildings. With ARCHICAD GDL, we have developed unique solutions for ancient style architectural design. We are one of the few companies that are capable of making BIM forward design for ancient style architectures.

About GRAPHISOFT

GRAPHISOFT® ignited the BIM revolution in 1984 with ARCHICAD®, the industry-first BIM software for architecture. GRAPHISOFT continues to lead the industry with innovative solutions such as its revolutionary BIMcloud®, the world's first real-time BIM collaboration environment; and BIMx®, the world's leading mobile app for lightweight access to BIM for non-professionals. GRAPHISOFT is part of the Nemetschek Group.