



Research Article

**ICONARP**  
International Journal of Architecture & Planning  
Received 25 March 2017; Accepted 10 November 2017  
Volume 5, Special Issue, pp: 103-116/Published 18 December 2017  
DOI: 10.15320/ICONARP.2017.29-E-ISSN: 2147-9380



**ICONARP**

# Re-Defining Traditional Bazaar Areas and Shade Structures Via Parametric Design Methods

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## Abstract

For the continuation of life, people created various equipment and goods. To create mutual benefits, they've exchanged the overproduced items with different products. This has begun the shopping act. By the increased amount of transactions, a need of defined area for shopping have arisen.

For a temporary time, trading areas have been developed at different locations at a certain period. In the course of time, beside trading, these areas served as socio-cultural spaces where the human relations were established. Moreover, demand of being able to immediately access to needed goods have emerged. This situation made having a permanent trading area essential. Therefore, enclosed and permanent trade areas from bazaar, inn, bedesten, arasta to shopping malls have emerged. Next to all these trading areas, traditional bazaar areas keep being established.

Nowadays, there is a need of providing some determined comfort conditions to the users for these street alley bazaars. Decreasing the

**Keywords:** Bazaar areas, folding architecture, innovative design, computation, environmental parameters

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effect of unfavorable weather conditions and providing supportive certain services and units (like WCs, security, cleanliness, etc.) are some of them. As a fundamental solution, without disengaging the user relations with the outside, shade structures are generally provided. Shade structures can support cleaning and similar jobs by gathering and using rainwater besides its purpose of protecting the user from bad weather conditions. Application examples of these systems are gradually increasing. However, it is necessary to develop new approaches, in order to stop these proposed shade structures, become prototypes and to adapt the proposal to its environment and to increase diversity.

In this study, a convenient shade structure and its alternatives, which are adapted to environmental conditions, were designed to create a sample model for other bazaar areas. In models, basically, folding design approaches were pursued. For production of these shade structure models, parametric modelling technics (Grasshoppers and Rhinoceros software) were used and different variations of model were generated. Chosen examples of models were evaluated in the aspect of feasibility. A comparison was made between the existing examples and our designed models. Ecological contributions of these models were also taken into consideration and harvestable rainwater amount by this system was calculated. Accordingly, advantages of the system to the bazaar area and to its environment were studied.

## INTRODUCTION

In order to maintain their survival activities, the human being has needed various materials. At first, while people were gathering what they need, this activity left its place to producing goods over time. People started shopping by exchanging their goods which could be produced in diverse fields. Shopping activity created areas where people can come together (Dinçer 2010).

In time, the shopping has become an activity that formed the identity of the cities. This activity, has triggered intense shopping axes in the city and various spaces on these axes (Ülker, 1999). Cultural differences and technological advancements of societies have caused these spaces to be changed in time (Koçhan 2015). While these spaces, where people can come together, were open areas near religious buildings during Egypt-Hittite period; they were transformed into central open areas (Agora or Forum) which were encircled by various buildings in the city center during the Ancient Greek and Roman era. The common feature of these areas was that various sportive and cultural activities, religious and administrative ceremonies were taken place in there. Due to the fact that, activities were short-term, products in bazaars were being presented on temporary stands (Dinçer 2010).



Some situations like growing cities, increasing population and instant access to needed materials have shown up in time. These reasons triggered the need of stable commerce areas (shops) which would be accessible every day, addition to short-term bazaars. By increasing consumption, these spaces transformed into markets, passages and shopping malls. However, nowadays, in contrast with the transformation in shopping spaces, sense of bazaar still continues in open areas and through street alleys with a little difference from its very first shape. These bazaars which were named as “district bazaar” are being set up weekly.

Bazaars are the most basic units of commercial areas. Local products, foods, clothes and households are sold in these bazaars. Nowadays, while some bazaars are established in places which were determined in urban planning, in some cases, they take place streets at the time of the event. When bazaar areas are observed, it is seen that some shading covers prevent the daylight underneath. Also, disorganization and complexity are really common problems. After some investigation in Karabuk city, some bazaar areas are remained at some nodes where traffic is dense because of environmental development overtime and people who use private cars to arrive are usually having parking problems. Besides, lack of public lavatories is a reality, so that people cannot cover their needs in street alley bazaars.

Surviving district bazaars have low comfort and unfavorable environmental conditions for their users comparing with other shopping spaces. These areas are not only suitable for climatic conditions but also can not satisfy personal needs like car park and sanitary spaces (Kartal, 2013). As a solution to this, especially in order to protect users from environmental conditions and maintain sustainability, various designs and competition projects (İstanbul Besiktas Fish Bazaar, Safranbolu Yeni Mahalle Thursday Bazaar, Antalya East Garage Bazaar Area Urban Design Competition, Morocco Casablanca Bazaar Area Design Competition etc.) have being developed recently. For some of these designs while the sustainability is a priority, for some of them it remains in the background. At the same time, some of the designs carry feature of being a prototype, so that, they cannot get integrated with the environment of the project area and its needs. For that reason, by utilizing modern-day technological opportunities, it is a necessity to increase easy-to-build design variations for bazaar areas. Also, these variations need to be designed appropriately for conditions of where they will be going to build.

Shopping malls which were composed by the historical development process of bazaars can answer certain public needs

today. However, even though traditional bazaar areas are our cultural heritage and still popular, they cannot meet public necessities properly. The intention is to enhance these areas to provide more comfortable shopping experience by having better visuality of bazaars and fitting daily requirements.

In this study, by utilizing opportunities of parametric design tools, on the basis of folding design models, an evaluation of shade structure examples, which were developed for Karabük City, Besbinevler 75. Yıl District Bazaar area, has been presented.

### **MASS CUSTOMIZATION**

Mass production is a way to produce things by utilizing standarts, rules or codes. While this method provide opportunities to have things more economic and standardized, by the technological advancements; users requests, demand or desire more personalized products. At this point, mass customization comes to existence as a new term and strategy; Mass customization (Dye, 2004).

Mass customization is a method that means configuring or changing the model at some points of the mass to fit in specific desires, or needs. This strategy creates opportunity to create flexibility, and also affordability in production process and gives us chances to develop new techniques to create differential, adaptive, collective and parametric designs throughout the design phases. By the opportunities of CAD-CAM programs and various production tools like 3D printers, and CNC milling machines, more complicated and non-repetitive designs in terms of making of architecture can be created. Despite all advantages, mass customization have several limitations in it. One of them is ratio/scale problem, and related to that affordability in production. Most of the examples are in small scales however by technological advancements and developing CAD-CAM programs in close future this is not going to be a constraint for mass customization anymore (Dye, 2004).

In this study mass customization methods have been used in terms of technology (Folded structures, Adaptability and Producibility) and local data concerned with lot (area) and natural & urban environment such as building, topography, plants etc. Mass customization materials and folding methods have been decided (Dye, 2004).

### **FOLDING IN ARCHITECTURE**

Folded plate models are structural systems composed of linear and planar components which distribute the load through the



direction of the connection line of folded plates (Moussavi, 2011). These models can generate different formations by getting together on horizontal (plan) and vertical (elevation, façade) planes. Count of folding can be increased in models within the compass of plan scheme and by a certain scale. The ability of increasing and decreasing heights with a determined scale on material connections provides an opportunity to create depth on structural system. Increasing the depth of folding enables plate surfaces to work as beams. This situation also supports the variety of forming in accordance with environmental factors. Using origami design methods creates opportunities for designers and engineers to analyze contemporary forms and structural systems, and it is also a chance to enhance unsatisfying current architectural and structural “vocabulary” of building materials (Sorguç et. al. 2009). Other than its load carrying feature, folded plates contribute architecture with various optical effects like tilting, waving, asymmetry, mirroring etc. (Moussavi, 2011).

According to Hemmerling (2010), there are three essential attitude of folding design methods in respect to design, manufacturing and performance. First, due to its “highly experimental, nonlinear and process-oriented” feature, folding design constitutes advanced opportunities and unpredictable results. Second, folding structures provides self-supporting systems and usually they are practical and material-efficient. The latter is its adaptability to find out best solutions in regard to material, form, structure and balance by modifying various physical parameters throughout the process.

Application examples can be listed as; plane hangars of Orly Airport - which were built in 1923 - are known as very first examples of folded plate models (Šekularac, et.al. 2012). Furthermore, Colorado Springs Air Force Academy Chapel by SOM, Yokohama Port Terminal, The First Presbyterian Church of Stamford (aka “The Fish Church”), St. John’s Abbey Church and Hex-Sys Office Building, etc. can be shown as some other extant examples. Among these, Hex-Sys building in Guangzhou, China distinguishes due to its similarities with this study related to forming and being sensitive to its environment. The building has a light, flexible, reusable and sustainable system. It composed of hexagonal geometric modules (Figure 1a). These geometric modules were designed centripetal to hexagon as a concave roofing system. Hexagonal concave modules were formed by the connection of sub triangle pieces. These modules form a structural system by getting together and they also help to gather rainfall water efficiently by upper surfaces and create an aesthetic view at the interior area (Anonymous, 2016).

Besides, many academic and special studies/works can be found through the literature search. The work of Cambridge University Students, “The Octahedron” work of LMNTs Architecture and Origami Pavilion by Tal Freidman etc. can be given as examples (Figure 1b and Figure 1c). In these examples, The Origami Pavilion (2016) has very unique similarities to this work with its way of design, thinking, form and how it was fabricated. The pavilion doesn’t require any additional support system, because the origami folding technics create a structural system and its branches where aluminum thin-shell plates connects each other. Similarly, by starting with paper models based on origamic techniques like reverse pattern, yoshimura pattern (diamond pattern), diagonal pattern and miura ori pattern (herringbone pattern), Buri and Weinand tried scaled wooden structures. With these methods, they pointed out linear relationships between folding depth and structural strength. Also, they have simulated that folded models can not only be used as building form but also the structure in the building elements (wall structure). They aimed to create timber construction panels by benefiting from economical ways and generating complex geometries. In terms of using environmental factors for parametric design, another study can be given as an example which mentions daylight optimization with a specific origami style named “kaleidocycle” (Elghazi et.al. 2014). In that study, a model called Kaleidocycle skin was designed by arraying Kaleidocycle rings within the hexagonal grid in order to calculate the daylight amount and compare it with existing facade systems. The work was conducted as two phases. First phase was to simulate base case and to get prior results. Second phase was about optimizing the system by changing parameters like opening of the Kaleidocycle ring or rotation angles in order to get best results for daylighting.



**Figure 1.** Hex-Sys Building (a) (<https://xxi.com.tr/etiket/hex-sys>, 2017); The work of Cambridge University Students (b) (Sorguç et. al. 2009); Origami Pavilion (c) (<http://talfriedman.com/origami-pavilion>, 2017).

## PROPOSAL MODEL AND ITS APPLICATION

With the intent of maintaining traditional bazaar culture and providing a healthy, comfortable and environment-friendly shopping activities, a study of shade structure was designed (Figure 2) by utilizing opportunities of parametric design models for the open bazaar area in Karabuk city – Besbinevler 75. Yıl district and it is also reachable from Cumhuriyet District. Existing bazaar area has a trapezoid geometry and 9800 sqm area. That area is surrounded by four story apartment blocks except its south-east direction. The site's downward slope is from north-west to south-east and there are a number of trees in two green axes at the north and south-east side.

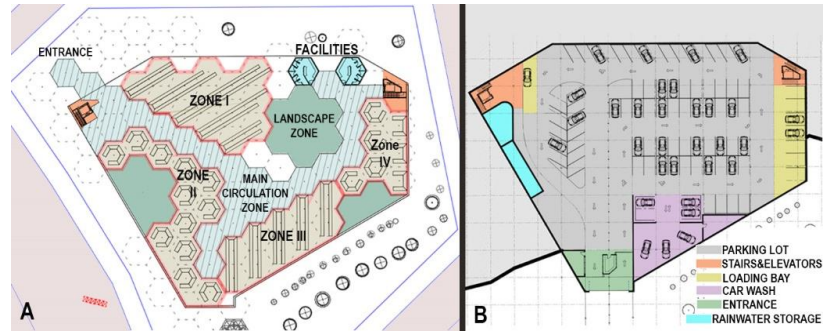


**Figure 2.** Site plan of proposal model.

A module was defined before starting the bazaar area design. The main reason for choosing modular system is to increase compatibility for other areas. As a result of an intervention to bazaar area, the entrance & exit can be made only at the upper level from a certain point (Figure 3a). Accordingly, it is crucial that circulation answers essential needs. For that reason, a main

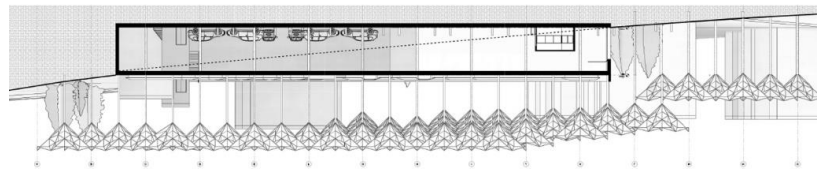
circulation axis was determined inside the area. Four different zones which hold various groups were placed adjacent to circulation axis to ease finding products. On the contrary of modern day bazaar sense, special landscape spaces are defined inside and beside of the area. By this way, the aim is to create a positive psychological influence on people. Air ventilation is thought by removing shading structures from these spaces.

**Figure 3.** Plans of Bazaar (A) and Carpark (B) Areas



In proposed model, leveling the slope was the primary aim that can create advantages to ease movement and carry goods with less effort. In this context, adding a level underneath the bazaar (Figure 3b), would be a solution for both parking problems and complexity. Beneath the bazaar, there is a car park, car wash and also storage tanks for rainwater harvesting. Access to car park is provided by stairs and elevators from two cores at edges of the bazaar (Figure 4, Figure 5 and Figure 6).

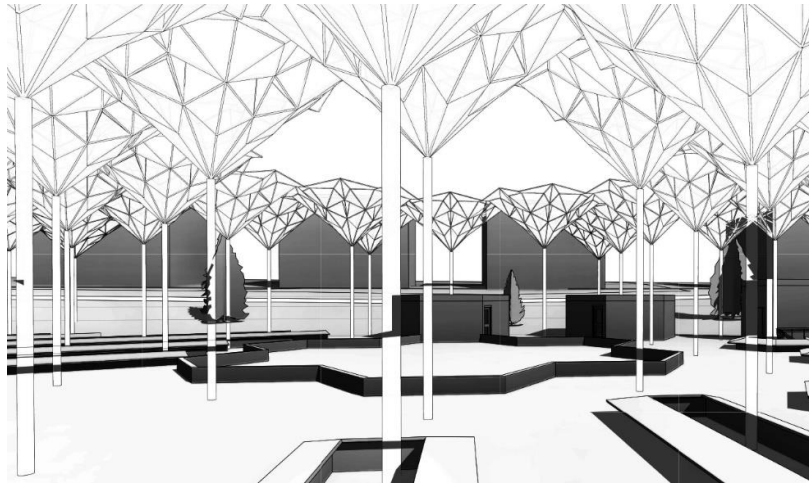
**Figure 4.** Section of bazaar area.



**Figure 5.** Perspective from outside of bazaar area.





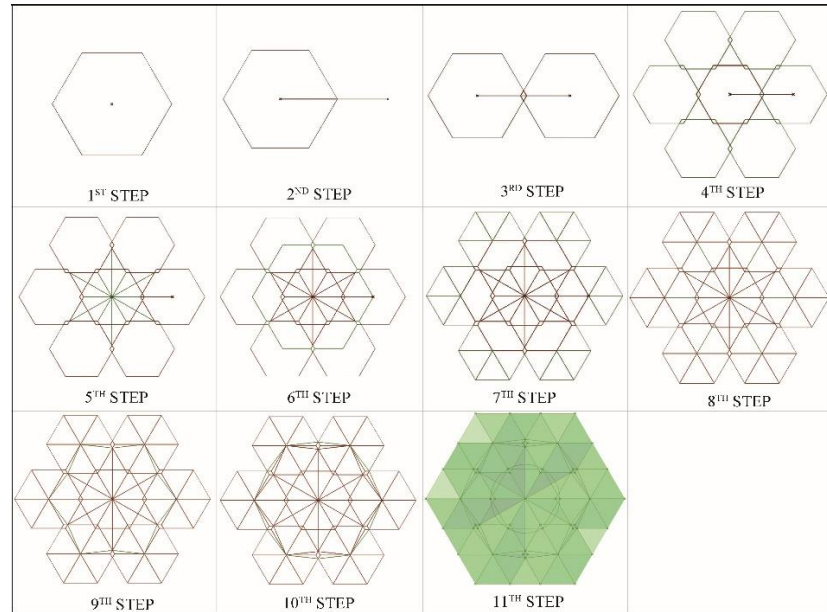


**Figure 6.** Perspective from inside of bazaar area.

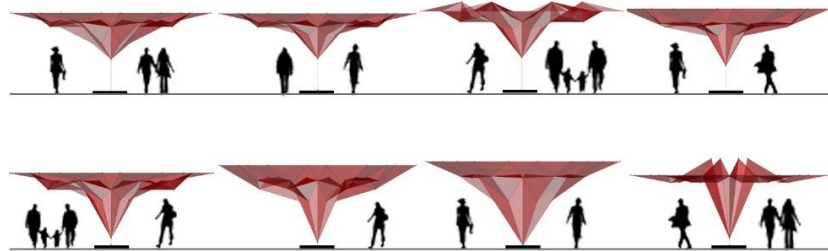
For the selected zone, proposed shade structure series' main frames were formed as polygonal geometric modules. Polygonal pieces of shade series were consisted of triangle surfaces which can generate different patterns by parametric variables which benefit from Rhinoceros -Grasshopper visual programming. These surfaces are tilted toward the centre of polygon in order to gather rainfall water efficiently. These tilts may vary from the inside out in regard to triangular patterns. By this way, 2D patterns also present different pattern examples in third dimension. Bowl-shaped model was designed to be carried by vertical pipes which can be adjusted for heights.

In this study, hexagonal shapes were used as polygonal components (Figure 7). These shapes consist of a hexagon in the center and other similar six hexagons around it. Intersections, corners, and center points of those hexagons match each other. Matching points define triangular surfaces. The distance between surrounding hexagons and center hexagon is used as a variable. Diversity can be attained every time by adjusting this variable. Hexagonal shapes are distributed on a hexagonal grid order. Thus, they define a pattern, which exemplifies folded architectural approaches, with together. Each unit of the grid determines domain limits of "distance" variable.

In third dimension, the height value was determined for every connection, intersection and center point of hexagonal shapes. While some of these values are connected to each other, some of them works independently (Figure 8). Height of center point of a module is related to environmental parameters. Furthermore, according to architectural requirements, the heights are constrained by minimum and maximum limits.

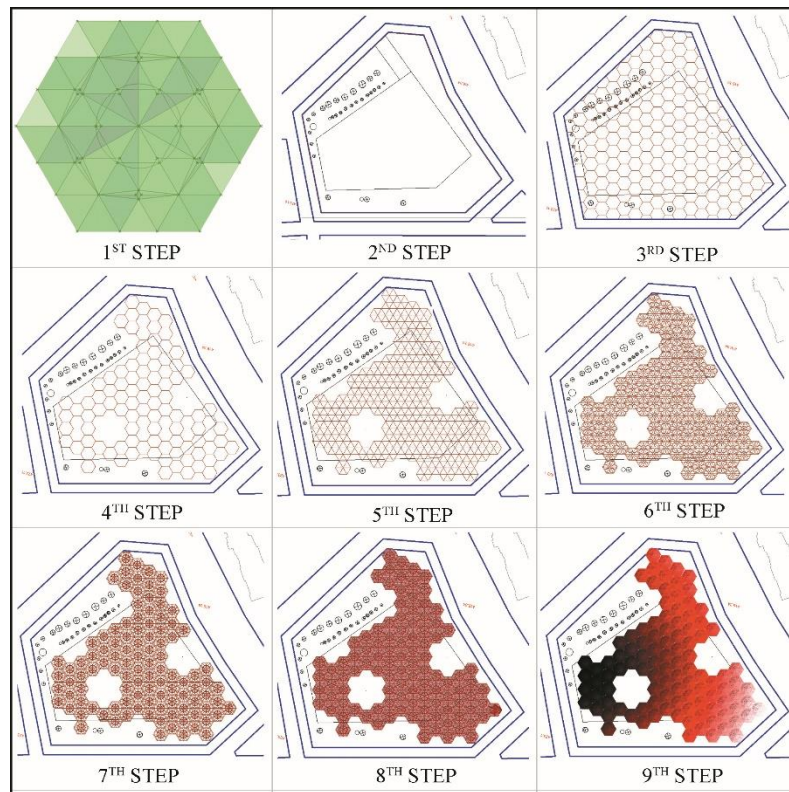


**Figure 7.** Formation of a hexagonal module.



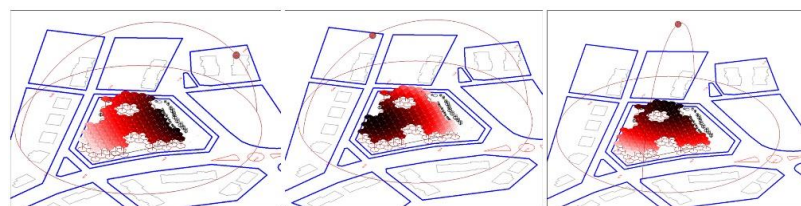
**Figure 8.** Façade variations of a hexagonal module by different height variables

Modules were proposed as 3m or 4m consoles by considering exhibition areas of goods in the bazaar, movement of users, and structural features of the shade structure. Existing green areas are used as limiting parameters to settle modules into the site. Tree series, in green areas, have an influence radius on model in respect to their size and height. Other than the limiting factors, these modules were settled in the hexagonal grid order which stay inside of the legal construction boundary of the site (Figure 9). Heights of the modules also were organized by taking human scale into consideration as in planning. Additionally, they are arranged simultaneously by considering heights of surrounding buildings and slope condition of topography. Thus, new varieties are attained.



**Figure 8.** Distribution and generation process of the module in the site

Beside decisions of geometric forms, material selection is considered in the proposal model. Accordingly, while creating these skeleton models, electrochromic glasses are thought to be used on surfaces for the purpose of utilizing natural light more and for shopping in a more comfortable area (Tavil, 2004). However, when we consider the high cost of this material, instead cost-efficient materials (like, glass, polycarbon or membrane etc.) can be used. Steel was decided as the main material of the structural system (Figure 10).



**Figure 10.** Simulation of Daylight effects on the proposal shade structure

Furthermore, calculations were made related to gathering and utilizing rainfall waters for sustainability intentions for the model which produced within the context of this work. According to this, 4,18 m<sup>3</sup> water can be gathered from one unit, and 393 m<sup>3</sup> water from 94 units that settled at the bazaar area. It is determined that gathered rainfall water can have stored at the proposed basement floor area. Gathered rainfall water can be used for multiple purposes like cleaning the bazaar area, irrigating green spaces and as tap water in WCs that are built for the bazaar and users.

## CONCLUSION

In this study, Solution proposals to some determined problems like complexity, parking problems, lighting, air quality, visual richness, basic needs etc. are sought via innovative design approaches. In this regard, an example model is developed for the bazaar area at hand. An upper shade structure is designed by utilizing opportunities of parametric design method within the context. As a result, throughout the process, obtained experiences and suggestions can be summarized as;

As it is seen in area study and from literature examples, folding models provide substantial alternatives. In proposed model, a certain geometric form is used for modular manufacturing. Different geometric forming's are thought that can be used for increasing diversity.

Recently, as it can be understood from the interest among the computational design subjects, it is obvious that parametric modelling tools provide plenty of alternatives and faster manufacturing opportunities. At the same time, relationships and limitations that are created by parametric modelling supports the occurrence of controlled diversity. These features are verified by evaluating in the context.

The design subject of chosen open district bazaar areas contains contemporary discussions like protecting natural resources, traditional and vernacular features. In the example of area study, these discussions also take place different from existing applications. These topics are linked to parametric modelling tools and contributed as limitation instrument to evaluate alternatives.

It is attempted to show that traditional bazaar areas can contribute protecting natural resources (water, sunlight etc.) effectively in the sense of sustainability. In design process, material selection is an important subject that needs to be taken attention beside planning.

Lastly, in order to maintain traditional bazaar culture, some improvement suggestions are presented via a design study. Furthermore, by support of different ideas, increasing their numbers becomes necessity.

## ACKNOWLEDGEMENT

This article is prepared by expanding the proceeding presented in the ICONARCH III, held at Selçuk University in May 11th-13th, 2017.



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## Resume

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