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BEYOND SINGLE USE:

How an Open Building or Infrastructure Model Can Help Revitalize Our Cities

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Increasingly, large buildings that serve multiple and changing uses show the characteristics of infrastructure-- offering space for customized and changing user requirements. This discussion paper addresses how and why this is the case and proposes that what are commonly known as "base buildings," "core," and "shell" are in fact a new kind of infrastructure.

Figure 1, Typical shopping center, Beijing.

Figure 2, Bank of China Tower, Hong Kong, I.M Pei, 1985-90; and Cheung Kong Center, Hong Kong, Cesar Pelli and Leo A. Daly, 1995-99)

Shopping centers and office buildings, for instance, have behaved this way for some time, prepared for change within their use category. Now we see large residential projects, hospitals, and educational facilities shifting toward this mode. Setting up all kinds of large buildings for continuous, if incremental, change whether or not the use is changed, is becoming increasingly important given changes in the nature of work, changing demographics, and the urgency of providing an inclusionary and equitable built environment. The implications for regulation, policy making, and for innovation in the building industry are important.

A significant existing literature addresses infrastructure in the built environment. Road networks on various scales and railway lines come to mind, as do water and sewer systems and power and communication networks. They all serve multiple users and frame the physical conditions for inhabitation. Decision-making and control for large capital assets such as these, whose design and use stretch over large territories and over long periods of time, is often hierarchically distributed and guided by both convention and explicit regulations. Governmental entities as well as private parties are involved in complex and changing patterns of initiative, financing, and management of such infrastructure systems.

We believe, based on experience over the past few decades, that an infrastructure model can be a useful way of seeing real estate assets of all kinds and can be a powerful guide for the creation and management of a resilient and sustainable building stock. To achieve this goal, everyday buildings should be designed and financed to operate beyond single use; that is, designed for change.

OPEN BUILDING: AN EXTENSION OF THE CONCEPT OF INFRASTRUCTURE INTO BUILDINGS

In large buildings, we see a tendency to separate a "base building" from "fit-out." These separated entities are also called "core and shell, and tenant work", "support and infill," or "Primary and Secondary Systems." Whatever words are used, the distinction is increasingly conventional and international, and it is mirrored in the real property and building industries' practices, methods, and incentive systems. Internationally, this separation of design tasks

and investments, and all that goes with it, is now called "Open Building."

For example, the developers and managers of commercial office buildings have used this distinction as a matter of convention for at least seventy-five years. Tenants lease or buy space in buildings in which the layout for each space is custom designed and can be individually adapted over time. Private and governmental institutions that own large administrative buildings likewise make that separation to accommodate ongoing relocation and reconfiguration of functional units. Large building companies have distinct, dedicated divisions to service both the construction of base buildings and the installation of tenant improvements or fit-out. Tenants own or lease fit-out partitioning and equipment (the latter usually called "FF&E"-- Furniture, Fixtures and Equipment in the United States) and, if owned, can sell it to the next users, or they may clear out the space when they leave, increasingly using parts prepared for disassembly or recycling, so that the space can be fitted out anew by the next occupant.

Another example is shopping malls, including those in airport concourses. Developers of these large structures give much attention to public space and functions (such as parking, public spaces and facilities, and so on) but leave retail space empty. Overall architectural, technical, space and signage standards are established and documented in detailed tenant handbooks. This enables retail chains to lease space and bring in their own designers and fit-out services in a process that enables rapid turn-around of space for new occupants, without disturbing the shared infrastructure or neighboring tenants.

This way of using built space constitutes an already substantial market, which, in turn, has given rise to increasingly profitable and well-organized supply chains that serve the demands for tenant "fit-out." Both sectors – base buildings and fit-out - include finance companies, product manufacturers, design and engineering firms, construction companies, and a host of other specialists. Regulatory officials and the policy environment in general have adjusted to this reality.

WHY HAS THIS TREND EMERGED?

The emergence of this phenomenon lies at the convergence of six dominant characteristics of the contemporary built environment and the way we handle its transformation.

- *First is the increasing size of buildings, which often serve diverse organizations and thousands of people who come and go in a relatively stable architectural setting.*
- *Second is the dynamics of the workplace and the marketplace, where uses are increasingly varied and changing.*
- *Third is the availability of, and demand for, an increasing array of equipment and facilities that serve not only the real estate assets (both base building and tenant fit-out) but the users. In that convergence, large scale real estate interventions make simultaneous or integrated design of the base building and the fit-out impractical; user-level decisions are effectively deferred and inevitably change over time in any case.*
- *Fourth, social trends towards the individualization of work make functional specificity increasingly personalized. Greater complexity and variety in the workplace demand adaptation, and this entails architectural components with shorter use-life, such as partitioning, ceilings, raised floors, bathrooms, kitchen facilities, specialized equipment, and so on.*
- *Fifth is the urgent need to recognize and respond to the crisis of climate change in the*

production and transformation of all kinds of everyday buildings by saving precious natural resources and adopting the principles of a circular economy.
- *And sixth, social media and digital technologies are transforming and are being transformed by changes in the way we work, live, interact, and receive services.*

This separation of base building from fit-out – observable everywhere in the world - includes utility systems as well. Adaptable piping and wiring systems on the fit-out level, for example, connect to the shared and more fixed main lines in the base building, which themselves connect to the higher-level infrastructure elements that serve a district or the entire city.

In this separation of decision-making, we see a significant contrast. On the one hand, we have what is to be done on the user level – personalization, decision-making and responsibility for those decisions. On the other hand, we have what is understood to be the traditional long-term investment and long-term functionality of the building, which serves many.

This is the reason for the emergence of the "base building" as a new kind of infrastructure. The opportunities to rethink function-driven architectural typologies in this way are exciting, and we believe they should be taken seriously.

The distinction here is not strictly technical, but is better understood as happening between "levels of intervention" as has always been the case when we compare infrastructure in the conventional sense with what the infrastructure is serving. In the case of buildings, the comparison of base building and fit-out has multiple dimensions, including the following:

BASE BUILDING	**INFILL or FIT-OUT**
Longer-term use	Shorter-term use
Shared-service related design	User-related design
Heavy construction	Lightweight components
Long-term investment	Short-term investment
Equivalent to real estate	Equivalent to durable consumer goods
Long-term mortgage financing	Short-term financing

HOSPITALS ARE EVOLVING IN THIS WAY

The application of this distinction is already evident in hospital construction. More than any other building type, hospitals are functionally diverse and technically complex. Their design must accommodate changes in demographics, diseases, treatment procedures, equipment, doctor's preferences, and regulations – with concomitant demands for new spatial adjacencies and configurations. These factors are forcing project leaders to calculate a shorter use-life for work done at the fit-out level.

When this distinction between "base" and "fit out" is recognized, the construction of hospital base buildings starts before detailed fit-out design has been finalized, allowing a substantial shortening of the critical path for projects. Currently, it is not exceptional that seven years elapse between the start of planning for a large medical facility and start of operations. Much of that time is spent determining the specifics of what we now can label fit-out, during which time, in conventional practice, overall design is on hold. Despite the amount of time invested in planning detailed functional adjacencies, layouts, and equipment, chances are that these specifics will, to some extent, be obsolete when the

building is first occupied. However, if a base building is itself conceived of as a project, the design of the fit-out can proceed while it is being built. Staff can make changes and/or defer decisions about functional layouts and equipment installation in a "just-in-time" fashion, without disturbing the construction schedule of the base building.

Adopting this new design strategy, some hospital clients build "shell" space, which they later fit-out or leave empty as "swing" space for use when the building must be altered and units of function redistributed or resized. In such cases, it is not uncommon that one firm is hired to design the "core and shell" and another the "fit-out." Examples of the implementation of this strategy include the Gonda building at the Mayo Clinic in Minneapolis by AECOM/Ellerbe Becket; the Banner Estrella Hospital in Phoenix by NBBJ with a second phase designed by SmithGroup (2005-14); and many projects by Cannon Design and ZGF Architects (University of Portland – 2014-9) throughout the US. A good European example of this approach is the large hospital in Kortrijk, Belgium, designed by the firm Baumschlager Eberle (2010-2017), and another overseas example is the Sammy Offer Heart Center in Tel Aviv, by Ranni Ziss Architects and Sharon Architects (2005-2021).

Figure 3, INO (Intensive Care, Emergency, Laboratory and Surgical Center), Inselspital, Bern, Switzerland, Peter Kamm and Kundig, Itten + Brechbühl, 2007-13

An influential European example is the INO (Intensive Care, Emergency, Laboratory and Surgical Center at the Inselspital Hospital in Bern, Switzerland (2007-2013). This is the clearest demonstration of the new thinking about the construction of large projects that are expected to have a long asset life while accommodating change. In that INO project, a distinction is made between what they call "primary system" (100-year life), "secondary system" (10–20-year life), and "tertiary system" (5-year life). This is planning process, called SYSTEM

SEPARATION, is now adopted as a matter of public policy for all public projects built by the Canton Bern Office of Properties and Buildings, the public sector entity responsible for the INO project and all other public sector projects in the Canton Bern. More than twenty projects have been realized using this approach, and they are not limited to healthcare facilities. (For more examples, see Stephen Kendall, Healthcare Architecture as Infrastructure: Open Building in Practice [Abingdon, Oxon.: Routledge, 2019].)

EDUCATIONAL FACILITIES WILL ALSO BENEFIT

Education at all levels – from kindergarten to universities – is experiencing unprecedented changes in teaching methods, technology, modes of learning, funding, and the relationship to their communities. Educational facilities, whether public or private, are necessarily long-lasting assets that are stronger when they establish a permanent physical and social bond with their communities. But at the same time, many school systems are moving to incorporate a broad array of community-based activities, extending their hours of operation well beyond the normal school day, and rethinking how learning takes place. A recently completed project for the Santa Monica School District in Los Angeles is a case in point. The client was convinced that the Open Building approach advocated by the design team (HED and Moore Ruble Yudell Architects) made sense. (More information here)

Figure 4, (Discovery Building, Santa Monica High School, HED + Moore Ruble Yudell Architects, 2018-21

Universities, too, are changing, but at the same time, for many reasons, they aspire to establish traditions and achieve stable longevity. The MIT "main group" of buildings, built between 1913 and 1916 on the Charles River in Cambridge, Massachusetts, is an excellent example of a solid and capacious base building that has undergone substantial overhaul, upgrading of its mechanical systems and internal reconfiguration while retaining its spatial and structural integrity. This is an example of a base building as infrastructure, a model for the 21st century academic research and learning environment.

RESIDENTIAL CONSTRUCTION IS SLOWLY MOVING IN THE SAME DIRECTION

The need for a base building type of infrastructure is also evident in residential construction around the world. While housing projects have become bigger and continue to be understood as unified entities, residential life is changing and tends to become more individualized. For generations, the design of large-scale multi-family residential projects has reflected the tension between the demands of efficient building logistics and economy and users' individual (and changing) preferences. We now understand that such projects can add value by the introduction of a separate fit-out level serving individual / independent occupancy units. This enables (but doesn't guarantee) that residents can determine their own dwelling layouts and equipment, or, in rental projects, the developer can make decisions for each dwelling independently while creating a base building that serves all the occupants and maintains its value for many decades-- or generations.

While the base building approach in residential construction has often been considered desirable but not economical, it is important to note that recent projects are commercially driven. This changes the economics, since investment in the base building can be amortized over a longer term than traditional buildings. In addition, higher user satisfaction translates into higher rental rates and sales prices. Examples of this new paradigm include, in Helsinki, the Plus Home projects (Esko Kahri Architect) and the TILA and HARKO projects (Pia Illonen Architect for the Sato Development Company). In Amsterdam, two SOLIDS projects – one designed by Tony Fretten the other by Baumschlager Eberle Architects and other projects, including PATCH22 AND TOP-UP (Tom Frantzen) and a number of SUPERLOFTS projects (Marc Koehler) and others around the Netherlands. There are also many in Japan and the People's Republic of China. Some of the Chinese projects were created by a key government agency that was inspired by a 2008 law in Japan incentivizing long-lived buildings. (For more examples, see Stephen Kendall, Residential Architecture as Infrastructure: Open Building in Practice [Abingdon, Oxon.: Routledge, 2022].)

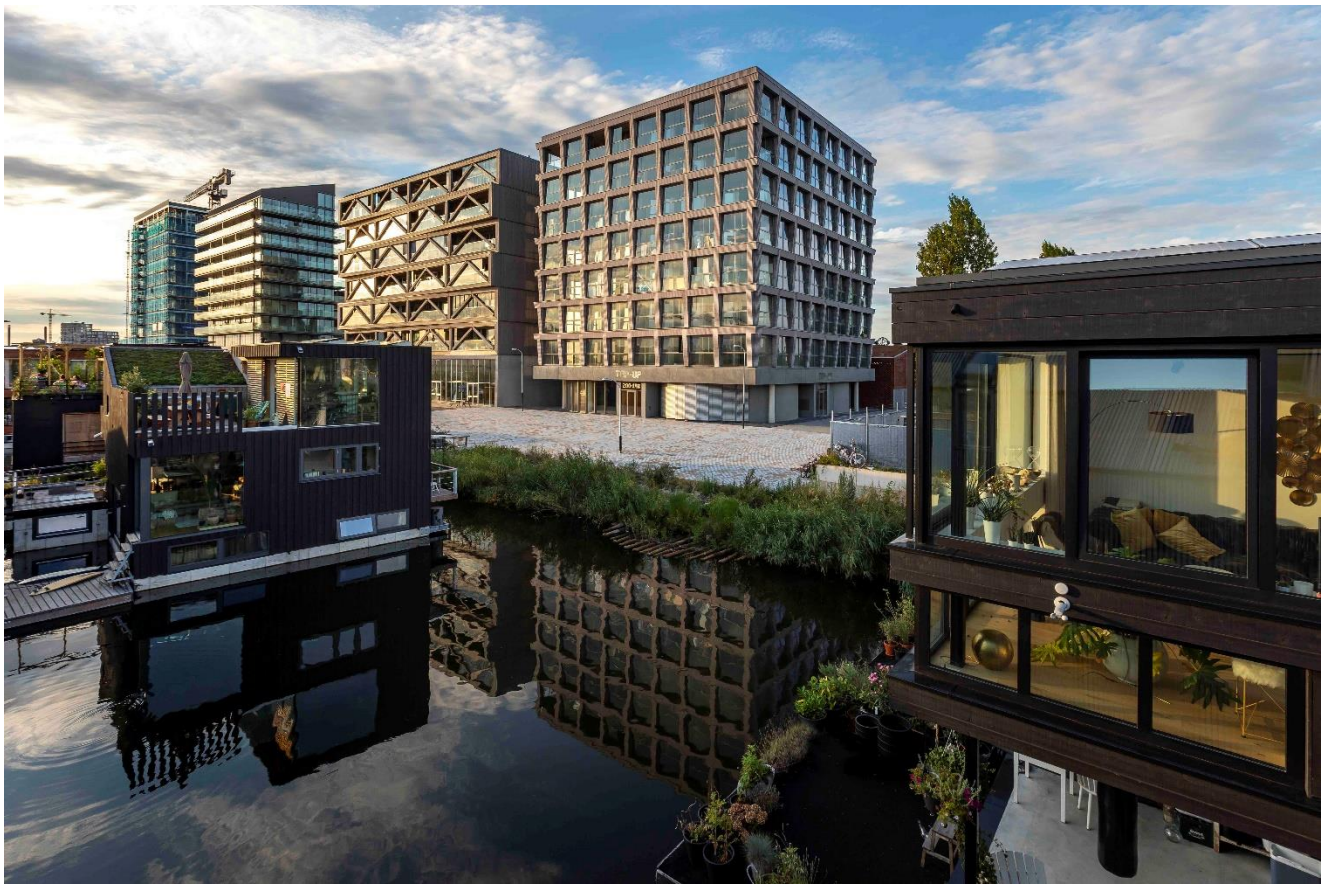

Figure 5, TOP-UP, Amsterdam, Tom Frantzen et al., 2016-19

There is some evidence of this kind of activity in the attached single family home market in the United States, in cases when "production builders" have thought in terms of producing "volume" (empty shells) and in luxury developments where largely empty units are offered for sale. In addition, the methodology of adaptive reuse, whereby old warehouses and office buildings are being remade for residential use, often resembles base building/fit-out distinction discussed here. Many of these projects have won awards.

FINE GRAINED LARGE PROJECTS

Release of the tension between conflicting demands at the small and large-scales is the most important aspect of the growing recognition of the importance of base building infrastructure in contemporary building and real property development. As is usually the case, release of tension will encourage new energy and innovation. The trend heralds the advent of the 'fine grained large project'.

To put it another way, as projects grow in footprint and volume, the pedestrian environment has become increasingly three-dimensional. Large commercial office buildings are vertical extensions of the traditional urban fabric. The high-rise apartment building is topologically no different from a gated community. Understanding the base building as a new kind of infrastructure opens the way for truly three-dimensional urban design.

Buildings and urban compounds have always tended to have gates. We are not surprised that behind these gates we find another urban environment with successive levels of public

and private space. This urban territorial stratification has been characteristic of cities in history for millennia. It is already here, in practice if not in the theories of the contemporary city, and it will find expression in a truly contemporary way when base building infrastructure finds its way into general architectural practice.

This shift toward a new way of understanding and investing in large projects challenges traditional professional practice in design, construction management, financing and legal and regulatory systems. The longer life span for the base building infrastructure, made possible by its adaptability to short-term inhabitation, allows increased investment in the public space offered by such infrastructure.

The architectural and management potential of this new trend invites serious exploration. It is important to say that observation of such projects around the world tells us that implementation is not a technical problem. The needed sub-systems and hardware are already largely available. But their handling and their allocation in a new timeframe need to be reconsidered seriously. The true challenge posed by this new trend is to rethink professional habits and conventions to correspond with new ways of designing, project management, business formation, and cooperation.

While new economic and regulatory frameworks need to be worked out, it is already possible to state in broad outlines how the fine-grained large project may enable, if not stimulate, a number of new developments. Two are immediately evident: the emergence of a distinct fit-out Industry and meeting the sustainability agenda. There may be more, and all need further study to unlock their potential benefits and to avoid the risks inherent in new ways of working.

THE EMERGENCE OF A DISTINCT FIT-OUT INDUSTRY

Application of the distinction between base building and fit-out to large-scale residential projects, although based on the principles observed in office buildings and shopping malls, is particularly important because it affects a very large market whose potential is not yet understood or exploited.

It is well understood that industrial manufacturing is most effective and dynamic where individual users are directly served. Witness the automotive, electronics and telecommunications sectors, all of which have learned to be very sensitive to individual demand. The potential market for residential fit-out approaches the size of the automobile industry. Designing base buildings understood as 'infrastructures for living and working' may well stimulate the evolution of a distinct fit-out industry that will accelerate innovation and distribution of new fit-out product/services and systems.

In Japan, the first formal fit-out product/service targeting the gut-rehabilitation of post war residential buildings as well as newly built base buildings, was launched in the market in the early 2000's. This service does useful work in the re-activation of older, well-situated and technically sound apartment and office buildings that need to be upgraded and adapted to meet new living and working standards. Technical sub-systems and products that can be integrated in partial or full fit-out "packages" are increasingly available in the international building supply market. Yet despite constant innovation in the design and production of these subsystems, the conventions of Japanese construction continue to block the wider implementation of fit-out strategies.

In 2018, the China Institute for Building Standard Design and Research released its "Design and Assessment Standard for Long-life Sustainable Housing." They have also promoted an Infill industry (their term for a fit-out industry). A number of sophisticated "industrialized interior decoration companies" are active in the larger cities of China. One, HENENGHOME, has delivered more than 100,000 infill (fit-out) packages in both the social and for-sale housing markets in the last few years, to be installed in base buildings in which dwelling units were left empty, ready to be filled-in one-unit-at-a-time by trained installation teams. A complete infill (fit-out) package can now be installed in seven days by a four-person team. This company is establishing factories and showrooms all over China and is branching out into the office, educational and healthcare sectors. A spin-off infill (fit-out) system is being developed by a research and development arm of the Beijing city government; this will be made available in 2023 to any Infill (Fit-out) company that wishes to use it.

In general, the creation of a genuine, certified fit-out industry is not a technical or industrial design problem. As noted above, with the availability of products and subsystems like partitioning, bathroom and kitchen equipment, piping and wiring, what is needed is the introduction of new kinds of businesses to meet new demands. Some may employ installation teams modeled on the "work cell," which is familiar in automotive manufacturing. When fitting out an empty space in a prepared base building, such a trained team will bring in all the ready-to-assemble parts – organized off-site in boxes and bundles – and install everything before handing over the finished space, together with a users' manual. This methodology avoids the disruptive sequencing of subcontractors, which produces so much inefficiency, disruption and quality control problems in conventional building practice. Backed up by sophisticated data and logistics, this combines efficiency with customization at a wide range of price points. The same methods can also be very effective in repositioning office buildings, warehouses and other building types that have outlived their initial uses.

It is important that the legal and economic frameworks needed for the development and growth of such an industry are put in place by local and national government bodies, and that financial institutions and developers understand the market potential. For example, building regulations in some countries require that bathrooms and kitchens be placed exactly above each other in multi-story residential buildings. Such laws are a reaction to poor quality control in conventional construction and need to change to help stimulate the implementation of this strategy for sustainable, adaptable residential architecture.

The useful distinction between the long-term architectural asset and the shorter-term equipment fit-out in residential construction can also be harnessed in the construction of attached (or row) houses. The building of an architectural shell--distinct from the dwelling unit's inside layout and equipment—is an approach that can be adapted to this variety of housing. The fit-out industry that can deliver ready-to-assemble product bundles to large buildings can also serve here, where large development projects, encompassing many attached units, can benefit from the services of fit-out businesses.

Roughly speaking, the goal should be to provide the rudimentary fit-out of a small dwelling unit for a cost that is close to the cost of the car its occupants use. This comparison suggests the magnitude of the shift we have identified – entailing the development of an entirely

new industry of impressive scope, which manufactures and delivers parts that are best called durable consumer goods. The trend toward creating a "base building" infrastructure thus also allows the building industry to come to terms with industrial production.

MEETING THE SUSTAINABILITY AGENDA

It is easier to build base buildings that are well insulated and built for long-term and efficient net-zero energy performance when they are freed from intricate and complex fit-out demands. Double envelopes can be designed to meet the highest building performance standards, reducing heating and cooling loads while providing ample natural illumination. On the other hand, fit-out components and parts - those that consume energy and are particularly related to on-going resource consumption in buildings – can be clearly aligned with differentiated and decentralized responsibilities (i.e. between the commons – base buildings, and fit-out). This clarity of responsibility is even more important when facade elements become part of the fit-out decisions in large buildings whose diverse occupants have varied expectations. We see this today on the street level of most urban mixed-use buildings, where commercial tenants can and do design their own store fronts.

Because individual fit-out users (households, medical departments, occupants in mixed-use buildings, etc.) will search for new products and services, accelerated development of new products and services will support the large-scale re-orientation of construction to meet the demands of a carbon free ecology. In fact, the United States Green Building Council's LEED rating system already recognizes the distinction between base building and fit-out in the commercial market, and the best construction companies already deliver high-performance buildings with well-insulated building skins. Similar developments are well underway in Europe and Japan.

CONCLUSIONS

An international "Open Building" network has been active for some time, documenting and supporting these developments. Achievements over the last three or four decades are now substantial and increasingly well reported. (For example, *Architectural Design*, September 2017: *Designing Buildings for Change;* and Stephan Kendall (ed), *Residential Architecture as Infrastructure: Open Building in Practice*. (Abingdon, Oxon: Routledge, 2021).

A general trend is now apparent in various kinds of real estate investment – in workplaces, residential, commercial/retail, educational facilities and health care - which can be understood as the emergence of a new kind of infrastructure. This trend is the result of forces in our society that are not new, but which are slowly but perceptibly altering the way we deal with buildings. It is safe to assume that these trends – toward larger projects, greater individualization, and the increasing availability of sophisticated equipment and utility services - will not be reversed. This new "base building" infrastructure invites recognition and active development, and investigations of the digital design tools needed to support its added complexity. The resulting impact on real estate and architecture will be significant. The building industry – and the society it serves - can ill-afford to be the only large industrial sector whose products become more expensive and of lower quality each year.

The problems to be faced in pursuing this goal are not trivial. The rate at which necessary

professional attitudes and skills can evolve and changes in accounting and management practices are implemented will determine the pace, direction and quality of change. But it is important to note that the examples that can be cited today have emerged from sound economic reasoning and a willingness to respond to market forces.

The time has come to establish a more focused and well-resourced platform for the study and development of what seems to have come about not as a new design idea, but as a new reality in the way that built environment comes into being and is transformed.

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